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CONTENTS.

WALSCHAERT VALVE GEAR AND CONSTANT LEAD

To the Editor:

I have been very much interested in the articles on the Walschaert valve gear appearing in the AMERICAN ENGINEER, particularly in that on page 218 of the June number. Its use, as well as the introduction of superheated steam and the four-cylinder balanced compound, shows that the American designers are looking across the Atlantic for valuable information, and finding it. In doing this, however, they have, in my opinion, obtained some information which is not correct.

That the Walschaert valve gear has very decided advantages under the conditions now governing the design of American locomotives there can be no doubt, but it does not necessarily follow that the feature of a constant lead for all cut-offs and speeds is desirable.

In the article in the June number it is stated that it is difficult, with the Stephenson valve gear, "to obtain sufficient lead with large cylinders in the longer cut-offs and at the same time keep down the lead and consequent preadmission and excess of compression in the shorter cut-offs." This assumes that the lead for the longer cut-offs is an advantage for large cylinder engines. A little farther on in the same paragraph this assumption is stated as a fact, the reason given being that a constant lead for all cut-offs "properly cushions the reciprocating parts—saving steam and reducing the pounding of bearings."

The fact that lead is not needed, under ordinary conditions, to cushion the reciprocating parts seems evident from the fact that the rods and reciprocating parts of locomotives never run so smoothly or with such freedom from pounding as when running with the throttle closed. It is a fact, which can be easily proved by observation, that there is practically no pounding when drifting at any speed from the highest to the lowest, even though the parts are decidedly worn and loose. Then why provide lead for the purpose of cushioning?

Assuming, however, for the sake of argument, that lead is desirable for cushioning the reciprocating parts, does it seem reasonable that the same amount of lead gives the proper cushion for all speeds? The clearance volume of the cylinder to be filled with a steam cushion is the same for all speeds, hence the time necessary for filling it with the proper pressure must be the same for all speeds, and it follows that this cannot be accomplished, with a constant lead, which necessarily shortens the time for filling the cylinder as the speed increases. The fact is that the cushion for a speed of 40 miles an hour should be sixteen times that for 10 miles an hour, because the inertia of the reciprocating parts increases as the square of the speed. It seems hardly reasonable to believe this can be obtained with the constant lead of the Walschaert valve gear for both these speeds.

Careful tests made with an indicator, and covering a considerable period of time, confirmed by the experience of a considerable number of American railroads as given in the proceedings of the Western Railway Club for February and March, 1897, to which could be added the present standard practice of several other lines, seem to prove beyond reasonable doubt that positive lead at full gear is a detriment instead of an advantage, and that a reasonable negative lead for full gear is an advantage. A little study of the matter will show the reason.

Assuming that a quarter of an inch is the proper lead for a cut-off of one-fourth the stroke, it is evident that, with the Walschaert valve gear, the steam port will be open a quarter of an inch when the crank pin is on the center with the engine in full gear. Under these conditions it is plain that the steam pressure in the cylinder can no more perform useful work in moving the locomotive than a man can by trying to lift himself by his boot straps, and is a positive detriment because it produces useless friction on the crank pins on that side of the locomotive, which imposes useless work on the engine on the other side where the crank pins are on the quarter and furnish the only power available for moving the locomotive.

When with the constant lead assumed and full gear cut-off the crank pin is approaching the center, steam will be admitted to the cylinder when the piston is about 2 ins. from the end of the stroke. Under these conditions the main valve is travelling very rapidly and the piston very slowly, so that boiler pressure is admitted to the cylinder almost instantly, and the results are a sudden taking up of all the lost motion in the rods, producing a severe pound, a needless sudden strain, and friction on all the moving parts, resulting in an appreciable waste of the power of the engine on the other side of the locomotive. If any one doubts this, let him try to pinch an engine off the center when the engine on the other side is disconnected. He will find it impossible with any ordinary pinch bar, though perfectly easy when there is no steam in the cylinder. If this experiment is tried when the lead in full gear is 1-16 in. negative it will be successful, because steam will not be admitted to the cylinder till it can do useful work in moving the locomotive. It, therefore, seems evident that, for speeds at which a full gear cut-off is used, positive lead, instead of being desirable, is just the contrary, and that the Walschaert gear is defective in this particular.

If lead is not needed to provide a cushion, what is its purpose? I would say to secure, as nearly as possible, boiler pressure in the cylinder by the time the piston reaches the end of the stroke, not before, and to increase the steam port opening after the crank pin has passed the center, so as to secure as high a steam pressure as possible in the cylinder up to the point of cut-off. If this is correct, it follows that the lead should increase as the speed of the locomotive increases, and the cut-off is shortened because, while the clearance volume to be filled is the same for all speeds, the length of time during which it must be filled decreases in the same proportion that the speed increases, if the lead is contant, while a lead which increases with the shorter cut-offs used with higher speeds, increases the time for the admission of steam.

Without fear of results, I venture the statement that locomotives having the Walschaert valve gear, if given the proper lead for the running cut-off, will be found to pound severely at the longer cut-offs and slower speeds, resulting in excessive wear to the parts involved, and will be found lacking in power on ruling grades, compared with locomotives having valve gear which increases the lead as the cut-off is shortened, and if given the proper lead for the longer cut-offs, will not have sufficient lead and will be lacking in power for higher speeds.

This statement should not be misconstrued as an opinion that the Walschaert valve gear does not possess advantages over the

Stephenson type, or, on the whole, will not prove the better of the two. It is simply an argument to correct the statement that a constant is better than a variable lead.

C. H. QUEREAU.

LEAKAGE OF PISTON VALVES.

To the Editor;

On page 255 of your July number, in "Impressions of Foreign Railway Practice" I note a reference to German experiments upon the leakage of piston valves without packing rings. Permit me to ask whether or not experiments have been made in this country, showing the relative amounts of leakage of piston and slide valves?

INQUIRER.

EDITOR'S NOTE.—Yes. The following quotation from the proceedings of the Master Mechanics' Association for 1904 describes such tests.—EDITOR.

On the Norfolk & Western Railway the method adopted for testing piston valves was to prepare a packing ring for each end of the valve chamber which could be brought up against the end of the valve, making it absolutely tight. This arrangement is illustrated in the report. The valve was then put on the central position on both sides of the engine and disconnected, and, being central admission valves, the steam could be readily admitted to the central portion, and whatever escaped passed down through each end of the cylinder. Pipes were connected up with the cylinder cock openings and the pipes passed through barrels of water, which condensed all of the escaping steam. In most cases gauges of mercury columns were placed on the cylinders and readings taken during the test. Three positions were taken of the valve: First, both valves on center; second, with the right valve ⅝ in. forward and left valve ⅝ in. back, and third, the right valve ⅝ in. back and the left ⅝ in. forward. In the positions ⅝ in. out of center, two of the rings are against the steam at one end. The results, however, do not seem to be affected by this.

The tests made for leakage of piston valves on the Lake Shore & Michigan Southern were conducted in the following manner:

The valve on one side of the engine was disconnected and set on center, and the reverse lever set so that the other valve, the one to be tested, was on center. A movement of the valves of about 1 in. was given during the test, by moving the reverse lever. The exhaust pipes were plugged so that no steam could pass to the other cylinder or out of the stack. Hose connections were screwed in the cylinder cock openings and steam condensed in barrels of ice water. The valve was well oiled and the lubricator kept running during the test.

Tests for leakage of side valves were made in the following manner on the Norfolk & Western: The valve tested had rectangular balance strips. The exhaust cavity was blocked and leakage was obtained around the balance strips, as well as the face of the valves.

On the Norfolk & Western, a piston valve in good condition loses from 250 to 400 lbs. of steam per hour. The worst valve tested on this road showed a loss of 544.31 lbs. per hour, with a mileage of 13,000 miles. The best slide valve on the Lake Shore & Michigan Southern showed a leakage of 348 lbs. per hour. This valve was in good condition, and had made a mileage of 17,500 miles.

The conclusions derived from these tests do not seem to favor either type of valve. The best piston valve shows a leakage of 268.56 lbs. per hour, and the best slide valve 348 lbs. per hour. If both kinds of valves were given equal attention the piston valve would be the better as regards leakage around the packing rings.

EFFICIENCY OF MEN.—If one of us does £150 worth of work a year, and earns £100, he is efficient; if he only does £90 worth, he is an inefficient machine, and will come to grief. He is like a 90-k.w. alternator which takes 100 k.w. to excite, though the analogy is not close. If he does £15,000 worth of work and gets £10,000, he is an efficient machine of much larger size, and his efficiency is much more satisfactory to himself. I may mention, in passing, that an efficient man must do more work than he is paid for. This is not always realized. A man who only did what he was paid for would be of no use to the world at large. His efficiency is zero, his consumption being equal to his output. The man who does £15,000 worth of work and gets £10,000, consumes two-thirds of the work himself; so his efficiency is 33 per cent., which is very high, even for an engineer.—*J. Swinburne.*

LOCOMOTIVE BOILER INSPECTION IN NEW YORK STATE.

The question has been raised by a correspondent as to what New York State has done in the matter of legislation concerning the State inspection of locomotive boilers. As other readers may be interested, the recent amendments passed by the New York State Legislature and signed by the Governor, which are now in operation, are reproduced as follows:

Section 1. Chapter five hundred and sixty-five of the laws of eighteen hundred and ninety, entitled, "An act in relation to railroads, constituting chapter thirty-nine of the general laws," is hereby amended by inserting therein two new sections to be sections firty-nine-a and forty-nine-b, and to read as follows:

49-a. Inspection of Locomotive Boilers.—It shall be the duty of every railroad corporation operated by steam power, within this State, and of the directors, managers or superintendents of such railroad to cause thorough inspections to be made of the boilers of all the locomotives which shall be used by such corporation or corporations, on said railroads. Said inspections shall be made, at least once every three months, by competent and qualified inspectors of boilers, under the direction and superintendence of said corporation or corporations, or the directors, managers or superintendents thereof. The person or persons who shall make said inspections, shall make and subscribe his name to a written or printed certificate which shall contain the number of each boiler inspected, the date of its inspection, the condition of the boiler inspected, and shall cause said certificate or certificates to be filed in the office of the railroad commissioners, within ten days after each inspection shall be made, and also with the officer or employee of such railroad having immediate charge of the operation of such locomotive. If it shall be ascertained by such inspection and test, or otherwise, that any locomotive boiler is unsafe for use, the same shall not again be used until it shall be repaired, and made safe. A certificate of a boiler inspector to the effect that the same is in a safe condition for use shall be made and filed in the office of the railroad commissioners. Every corporation, director, manager or superintendent operating such railroad and violating any of the provisions of this section shall be liable to a penalty, to be paid to the people of the State of New York, of one hundred dollars for each offense, and the further penalty of one hundred dollars for each day it or they shall omit or neglect to comply with said provisions, and the making or filing of a false certificate shall be a misdemeanor. Any person, upon application to the secretary of said board of railroad commissioners and on the payment of such reasonable fee as said board may by rule fix, shall be furnished with a copy of any such certificate.

49-b. State Inspector of Locomotive Boilers.—Within twenty days after this section takes effect, the State railroad commission shall appoint a competent person as inspector of locomotive boilers, who shall receive a compensation to be fixed by the commission, not exceeding three thousand dollars per year. Such inspector shall, under the direction of the commission, inspect boilers or locomotives used by railroad corporations operating steam railroads within the State, and may cause the same to be tested by hydrostatic test, and shall perform such other duties in connection with the inspection and test of locomotive boilers as the commission shall direct. But this section shall not relieve any railroad corporation from the duties imposed by the preceding section.

A GOOD INVESTMENT.—One of the largest manufacturing establishments in the world has sent a bright young man from its Philadelphia office to a leading university to prepare himself by a college education for the financial end of the business. This was not an act of philanthropy, but an investment on the part of the concern. It is likely to prove another wedge which will open up a new departure in the education of enterprising young men now employed in industrial works. —*A. E. Outerbridge, before Wharton students.*

IMPRESSIONS OF FOREIGN RAILWAY PRACTICE.

EDITORIAL CORRESPONDENCE.

BERLIN.

"Breakfast and booze" is the next entry in my notes. No one here seems to associate these two words, but they certainly play an important part in European shop practice. A few shops have changed to the working day of two periods, but it is not unusual for the men to come to work at 6 o'clock in the morning. They go home for breakfast and again for dinner at noon, thus cutting the day into small pieces. The custom is not satisfactory, and it cannot be made so. But it is not easy to change, so firmly intrenched has it become. One reason why the majority of the men like it is because they are quite dependent upon beer, and this system gives them an opportunity to go out for it. Numbers of cases were seen in the smaller German shops where the men had their beer in the shops where they could go for an occasional "pull" at the can while the machine worked on. Some were even willing to stop the machine for the purpose. To an American all this seems very strange. At this time of year (December) it is quite dark here at 7 in the morning, and it is considered a hardship for the women of the workmen's families to get up sufficiently early to provide a hot breakfast for the men in time to get to work at that hour. On one large railroad in England the advisability of providing hot breakfasts for the men at the shop is now being considered. At many large English shops mess rooms are provided for use at noon by all who live at considerable distance from the works. No cooking is done by the company, but the men's lunches are heated for them on steam tables and in ovens, and they may sit on benches in a large room and enjoy their noon hour at tables with the advantages of comfortable accommodations and pleasant surroundings which cost them nothing. The writer was invited to see the men at lunch at a shop where he happened to be at the noon hour. About 900 men sat at the tables and were evidently enjoying themselves. Why do not our railroads do this for their men? It costs little, but brings big returns.

Systematic circulation of technical papers is often a part of the work of the office staff of large engineering establishments, but probably no better use is made of them than at the works of A. Borsig, at Tegel. These works include locomotive, gas engine, stationary engine and boiler construction, each department requiring a special staff of engineers and managing officials. Every advance made in Germany or any other country is studied and applied, if possible, at Tegel. All of the important technical papers on mechanical and railroad subjects are received in the library of the firm. There are six employees who devote their entire attention to the current technical literature, to render it available for every one who may need it. All papers and magazines are carefully read in the library. The papers are marked in blue pencil, directing attention to valuable articles, and each paper starts on its rounds through the offices in a stout portfolio. A list pasted on the cover begins with the name of the head of the department interested, with the others in order below. Each one, to whom this paper comes, in turn sends it to the next one, reporting to the library its whereabouts. Every paper may be instantly located if needed, and when through its rounds it goes into the library for permanent file and binding. But this is not all. Every article is carefully indexed by the library staff, and in every possible way these people render this literature available, and therefore make it a working tool for those who need it. While the writer was looking over this system the chief engineer called for references on tests of superheaters as applied to locomotives. The references were at once found in the card catalogue, and a draftsman proceeded to the shelves of bound volumes for the desired information. Often the head of a department requests from his subordinates opinions in writing upon the descriptions of new designs or new developments, thus making sure that the papers are read in the right way. This interesting plan should have a place in every large industrial establishment. It is very noticeable that foreign engineers are careful readers of American papers, and are exceedingly well informed about American practice.

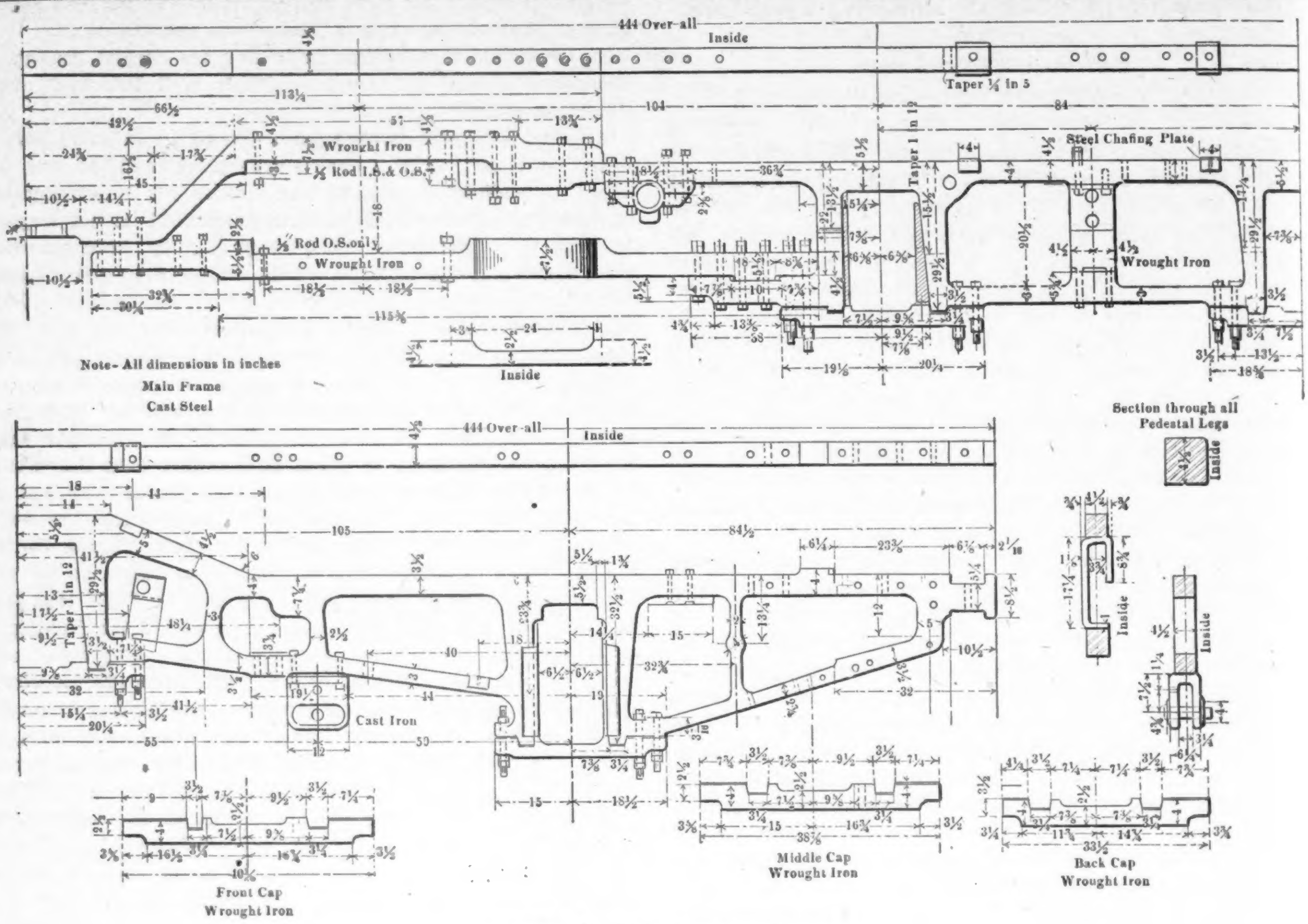
Another good plan is followed at Borsig's. In every shop a letter-box is put up in a conspicuous place, and the men are asked to submit in writing suggestions for improving the work of the plant or decreasing its cost. This is not original at Tegel, it is in use in many shops, but by close attention from Mr. Dorn, the manager of the works, fifty good suggestions have been put into effect in about a year and a half. The suggestions are usually accompanied by sketches, and sometimes by very good drawings. The subjects are gone into very carefully, and those having sufficient merit are put into effect, suitable records being made in a book. Employees receive cash prizes for their suggestions, the amounts varying from very little up to about $100. More than this would be paid for a specially good thing. This works very well in Germany, where the men are much steadier than in some newer countries. It should work even better in the United States, and it seems a little strange that railroads do not carry out an idea of this kind. It is said at Tegel that this plan has the effect of bringing latent talent to the front, and that it has served to interest the men more deeply in their work. In Germany our kind of labor difficulties are unknown. This serves to direct attention to the possibilities of applying a premium plan for new ideas to conditions like ours, in which the men are surrounding themselves with powerful leveling influences. Furthermore, a prize system of this kind would tend to lead every worthy workman in the shop to help the management to increase the efficiency of the plant. If introduced into a railroad shop, it might at first receive scant attention, and even scant courtesy, from the men, but there is no question of the value of the idea. At Tegel one of the workmen offered a suggestion with respect to the use of new high-speed tool steel in heavy lathe tools, which resulted in vastly reducing the cost of the tools. This man immediately received a substantial reward in money, and without doubt he will lie awake nights to work out other good ideas. A number of excellent improvements in methods have been made, and nearly all of them were unlikely to have been thought of by any one except the men who actually do the work. It might be an excellent plan to do something of this kind in connection with piecework. If a man knew that he would receive an immediate reward of $50 or $100 for suggesting a jig or some other short cut in his work he might feel more like presenting it.

As I stood at the gate of a large Continental general engineering establishment, saying an appreciative word of thanks for the painstaking courtesies shown me, I heard a rattle and roar such as would be made by a cavalry charge on Broadway. It was the shop men's wooden shoes as they rushed out like stampeding cattle, happy to be out of the works and free from the shop restraint. I never saw anything like this at home.

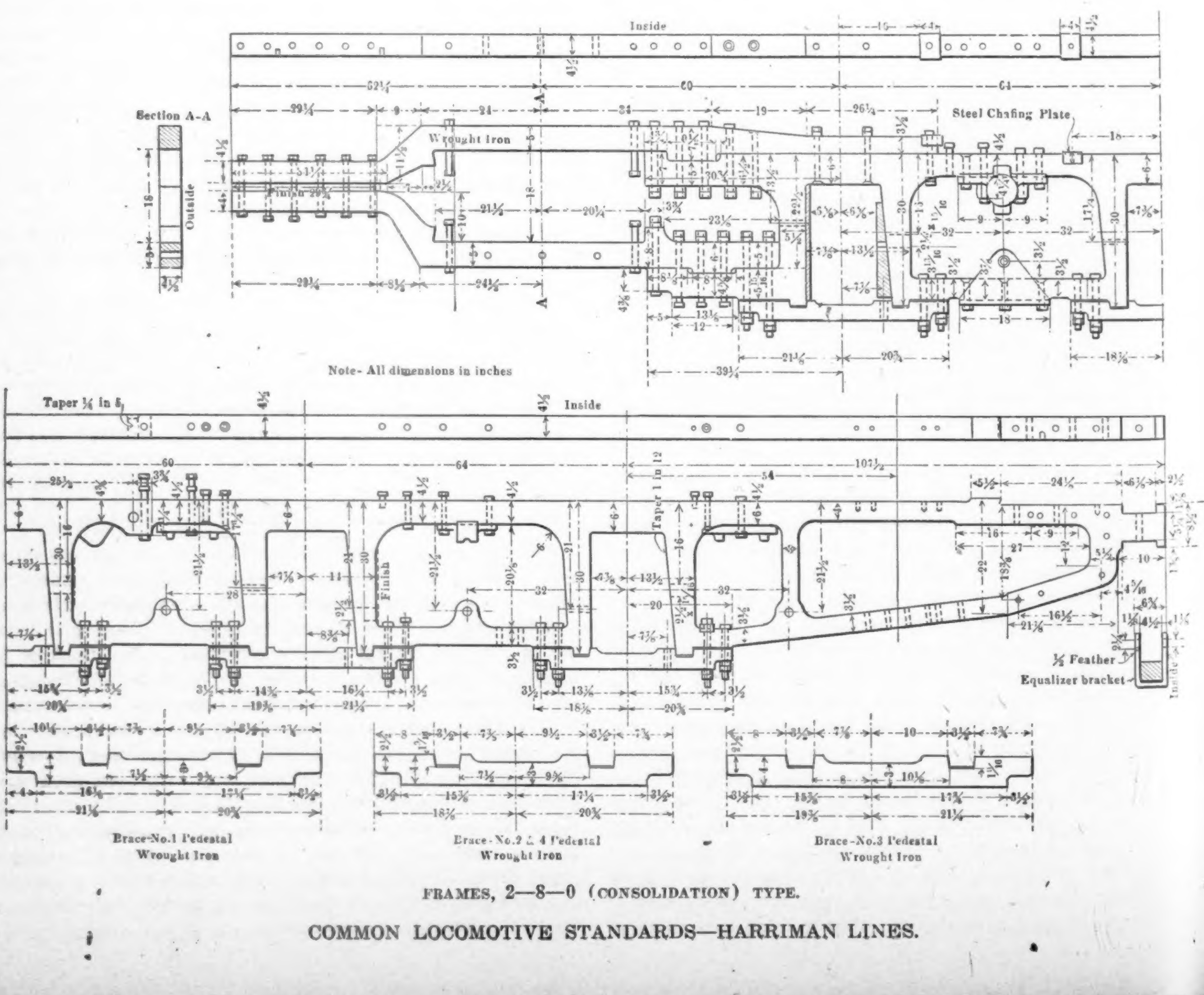
G. M. B.

(To be continued.)

GET AFTER THE CAUSE, NOT THE EFFECT.—In general, do not worry and scheme to simply repair troubles, but remove the cause. If you are burning out tubes in your boilers and keeping gangs of men putting in tubes or cleaning the scale out of old ones, do not scour the market to find the best flue scraper or where a man can be got for $3 to take the place of a man you are paying $3.25, but remove the trouble and install a plant that will soften the water. It is an easy matter, usually, to prove the saving; if the management refuses to spend the initial sum, hammer away with facts about costs until they will spend it. One firm in this vicinity put in 200 tubes in two months at an average cost in place of $7.50 per tube, a total of $1,500 for two months. A water softening plant of the proper size would cost about $8,000, and would pay for itself in two to three years.—*G. M. Campbell, Engineers' Society of Western Pennsylvania.*

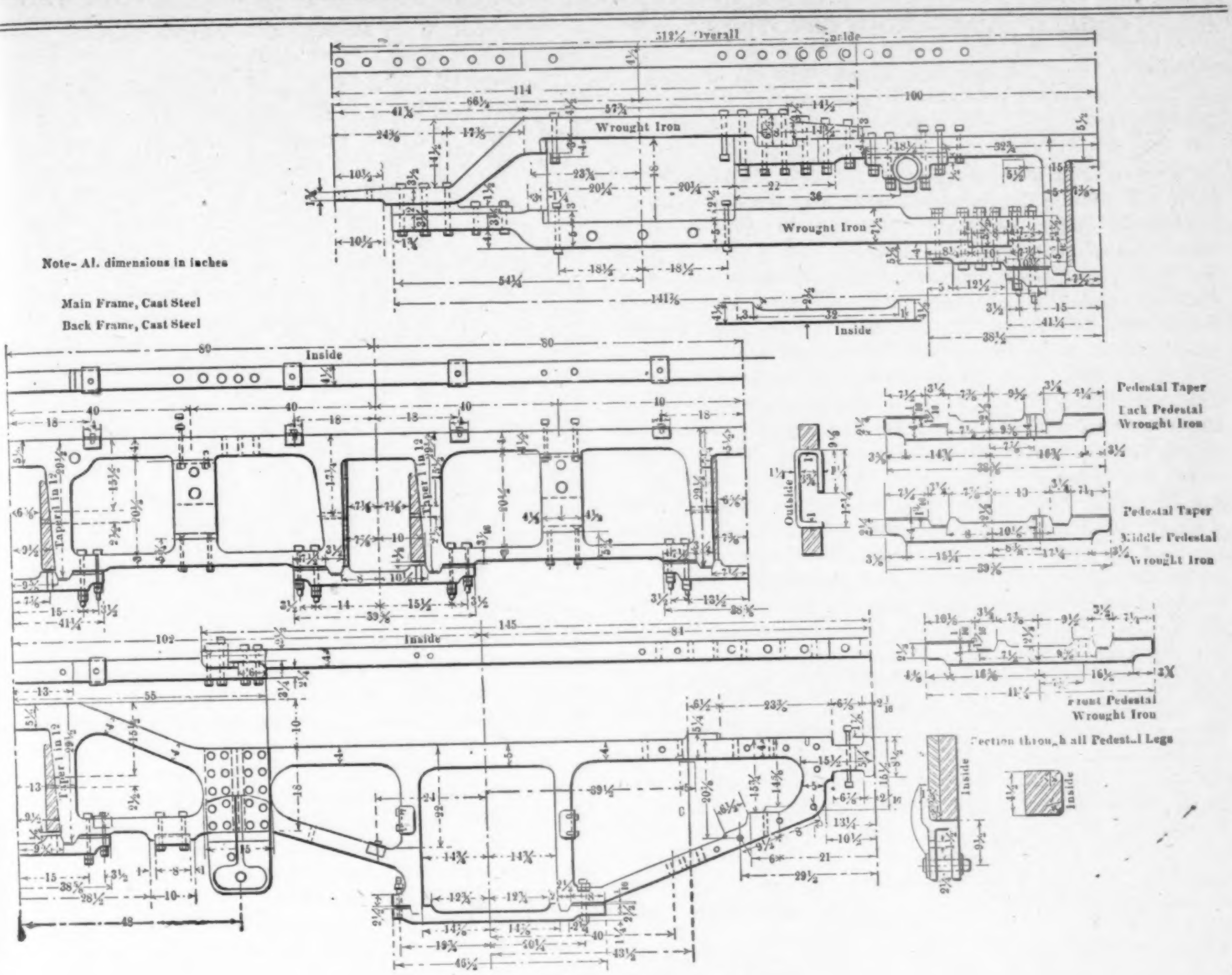


FRAMES, 4—4—2 (ATLANTIC) TYPE.

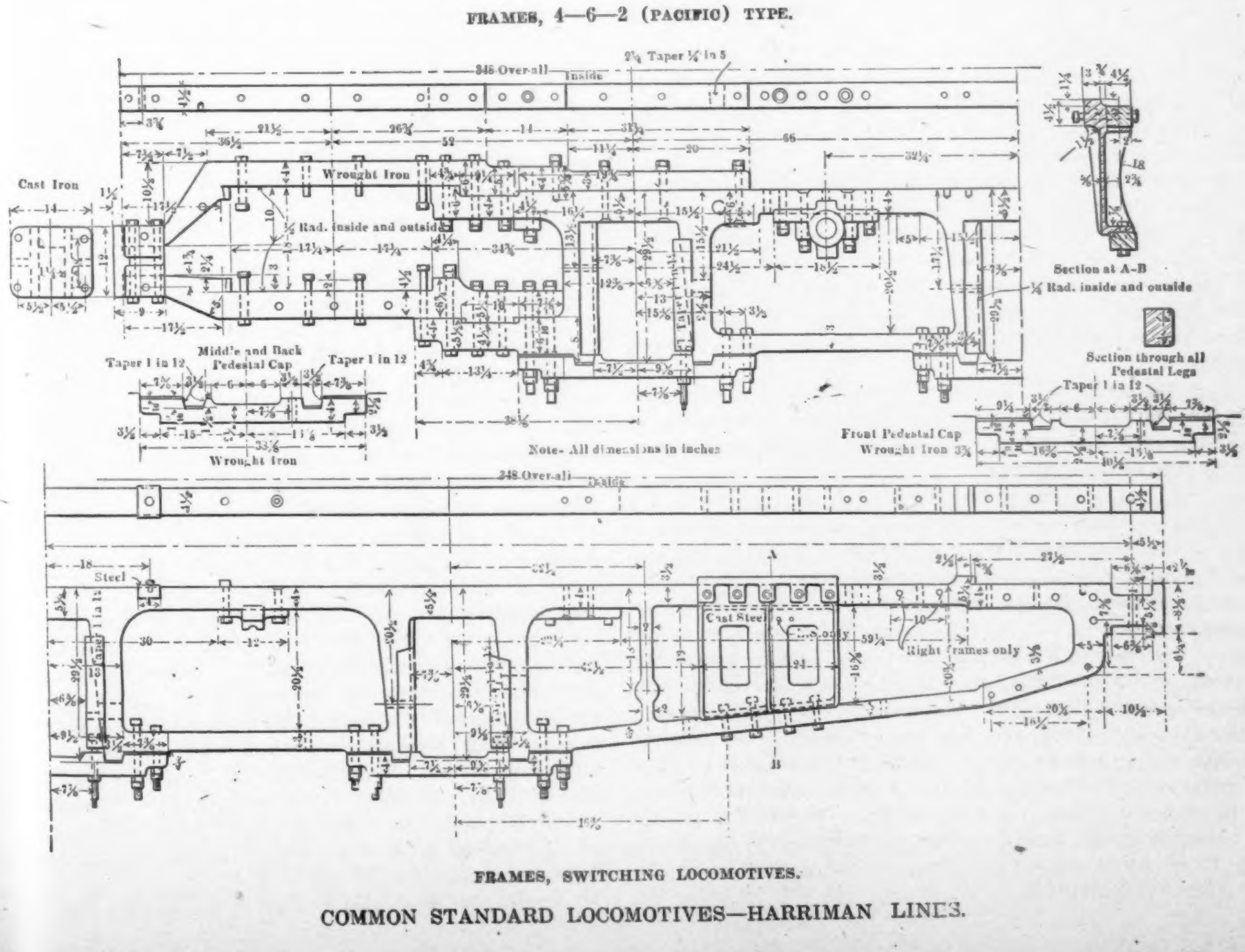


FRAMES, 2—8—0 (CONSOLIDATION) TYPE.

COMMON LOCOMOTIVE STANDARDS—HARRIMAN LINES.



FRAMES, 4—6—2 (PACIFIC) TYPE.



FRAMES, SWITCHING LOCOMOTIVES.

COMMON STANDARD LOCOMOTIVES—HARRIMAN LINES.

COMMON STANDARD LOCOMOTIVES.

HARRIMAN LINES.

V.

(*For previous articles see pages* 154, 200, 250 *and* 288.)

FRAMES.—While the frames of these four types of standard locomotives differ necessarily for the different types of wheel arrangement, they were designed with a view of using the same principles throughout. They are all of cast steel, and the pedestals are arranged for the standard driving boxes, which were referred to in the June number, page 200, the driving boxes being in two sizes for 9 x 12 and 10 x 12-in. driving journals. The Atlantic and Pacific types of passenger locomotives have 10 x 12-in. main journals, all of the other boxes being for 9 x 12-in. journals, thus rendering it possible to use but two driving boxes for all engines. The rear ends of all the frames are alike, to receive the same deck plate. All the frames are 4½ ins. wide, and all are spaced at 43-in. centers. As far as possible the same cross sections of frames are used throughout, but the consolidation frames are ½-in. deeper throughout, in order to secure additional strength and weight. All the frames have rails 5½ ins. deep above the driving boxes, with the exception of the consolidation, which is 6 ins. deep at this point. The pedestal binders are all of rectangular section, secured by double bolts, no pedestal tie bolts being used in any of these frames. The joints in the lower rails, between the main frames and front sections, are provided with double keys throughout and the upper joints with single keys, this construction being the same as that illustrated in connection with the Pennsylvania Class H—6—A locomotives, illustrated in this journal in June, 1899, page 181. There is a marked similarity in the common standard frames, and the pedestal binders are practically the same, varying only in length. All the frames have double front rails.

Because of the use of the Rushton radial trailer truck on the Pacific type and the rigid trailer truck on the Atlantic type, due to its shorter wheel base, the rear portion of the frames of the passenger engines differ in detail construction, specially as effected by the pedestals for the trailer trucks. All the frames are protected by chafing plates of ¼-in. steel for protection against moving links from wearing into them. All joints are double nutted.

By referring to the general plans of the standard engines on pages 155 to 158, it will be seen that the boilers are supported from the mud rings by flexible plates in the case of the passenger engines, by flexible plates and sliding bearings in the case of the consolidation engines and by sliding expansion supports in the case of the switchers. In the design of these frames specially careful attention was given to the frame splices.

The courtesy of Mr. W. V. S. Thorne, director of purchases of the Harriman Lines, in supplying this information is acknowledged, and that of the Baldwin Locomotive Company in furnishing the drawings.

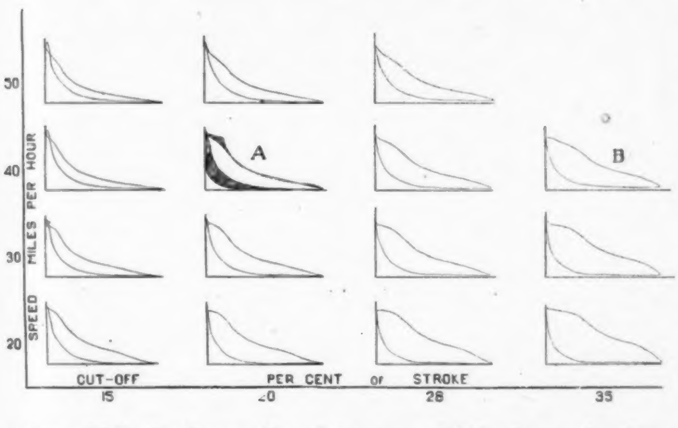
AUTOMATIC RECORDING INSTRUMENTS FOR POWER PLANTS.—One of the best devices for the control of a power plant is the automatic recording instrument recording steam pressure, voltage, current wattage, temperature on heating systems, pump speeds, etc. The most important in an ordinary power house are the steam pressure chart and voltage chart; the former records conditions in the boiler room, the latter, conditions in the engine room. The pressure line cannot be good unless the water level and fires are attended to, nor can the voltage line be correct if the switchboard is neglected. It is excellent practice to require that a written explanation of any irregularity in these charts be pinned to the chart, and an engineer or fireman with a too frequent repetition of bad charts should be discharged.—*G. M. Campbell, Engineers' Society of Western Pennsylvania.*

DR. W. F. M. GOSS ON VALVE GEARS.

From the beginning of locomotive valve gears, countless devices have been proposed affecting either the valve or the gear which gives it motion, whereby the card may be made larger than that which results from the normal link-driven plain valve. A typical card is shown at A. Concerning such devices, I would note that it is usually assumed, though the assumption is erroneous, that anything which increases the area of an indicator card is desirable. For example, in the engraving, for 20 per cent. cut-off and a speed of 40 miles an hour (card A) the plain outline is the normal card around which has been drawn a so-called improved card. The difference is the shaded area, and is presumably the result of the adoption of some new form of gear. Obviously, the shaded area represents increase of power. The first mistake that is made concerning the change is that the increase in power results in no expense. Again, while the truth of the preceding statement may be admitted, it is often urged that one may measure pressure and volume represented by two indicator cards such as are shown by these cards and derive therefrom an estimate of the relative amount of steam used per horse power per hour under conditions which each represent. Such estimates are, in fact, fairly reliable when made between cards agreeing closely in form, and when all conditions of running are the same, but, as a general proposition, nothing is more misleading. If there are differences in speed, or in initial or final pressure, or in the number of expansions, the percentage of the total amount of steam used which is shown by the indicator will change. Anything which may produce a change in the temperature of the metal of the cylinder at any one point in its cycle is likely to produce changes in the whole cycle. As is well known, a considerable percentage of the steam drawn from the boiler for each stroke of the engine condenses on entering the cylinder. While the interchange of heat causes some change in the amount of water in the cylinder as the piston proceeds on its course, by far the larger part of the initial condensation continues in the cylinder until the exhaust port is open, when it flashes into steam and disappears with the exhaust. While the process is a complicated one, and cannot within the limits of the present paper be accurately defined, the fact is that any change in the form of any line bounding an indicator card has its effect upon the amount of steam which must be admitted to make up the loss due to initial condensation. A change in the cycle remote from the period of admission may have as pronounced an effect on the quantity of steam required as a change in the period of admission itself. There is, in fact, no way to measure performance of a steam engine but by weighing of the feed or the exhaust. Again, a further illustration of the fact that the mere increase in the area of an indicator card is not significant, is to be found in the ease with which such increase of area may be secured. In locomotive practice it is quite unnecessary to adopt a new gear. If, under the conditions prescribed, the normal card (see engraving) is not large enough for the work, the reverse lever may be advanced on its quadrant until the cut-off is 35 per cent. of the stroke instead of 20, whereupon, in this particular case the normal card becomes equal in size with the card representing an assumed improved gear. The real question, therefore, may generally be stated as follows: Is the improved card at 20 per cent. a better card than the normal card of equal area at 35 per cent. cut-off? Will the former yield a horse-power upon the expenditure of less steam than the latter? It is upon this latter statement that the argument rests. No device which seeks to improve the steam distribution in a locomotive can succeed which does not save steam when compared with devices now in use. In proportion as it saves steam, it both increases the efficiency of the engines and increases their maximum power, for since the boiler capacity is limited, a pound of steam saved is a pound of steam available for additional services.

Turning now to a consideration of the margin upon which

those who would improve valve gears have to work, it must be admitted that it is not large. Results have already been quoted which prove that the locomotive with all its wire drawing, gives a horse power on less than 24 lbs. of steam per hour. This is near the minimum. From this performance of a simple locomotive having normal valve gear with its narrow port openings and wire drawing effects, we may turn to the Corliss engine, the action of which is generally accepted by all improvers of locomotive valve gears as a standard of perfection. Such an engine, with its large port opening, its prompt movement of the valves, can in fact be relied upon to give as good a performance as engines having any other type of valve gear operating under similar conditions of speed and pressure. Corliss engines having cylinders which are comparable in size with those of locomotives and which when under a similar range of pressure are, however, not common, and hence, it is not easy to command data for the proposed comparison. Generally simple Corliss engines work under a lower pressure than locomotives. The best performance of which I have been able to find record of a simple Corliss engine exhausting into the atmosphere is that of an 18 x 48 Harris-Corliss engine, for which the steam consumption was 23.9 lbs. per hour. The steam pressure supplied this engine was only 96 lbs. by a gauge. On the basis given the engine should, when supplied with steam at 180 lbs., which is the pressure



under which the locomotive data were obtained, require less than 23 lbs. of steam per horse-power per hour. Straining the facts applying to the two classes of engines as widely apart as a knowledge of existing data will possibly permit, we may assume that a Corliss engine, if given the advantages of the high steam pressure and high piston speed common in locomotive service may give a horse-power hour, or approximately 8 per cent. less on the consumption and 2 lbs. less of steam than the locomotive. This, then, is the margin upon which those who seek to improve the locomotive valve gear must expect to work. While it is well worth attention, it cannot revolutionize practice.

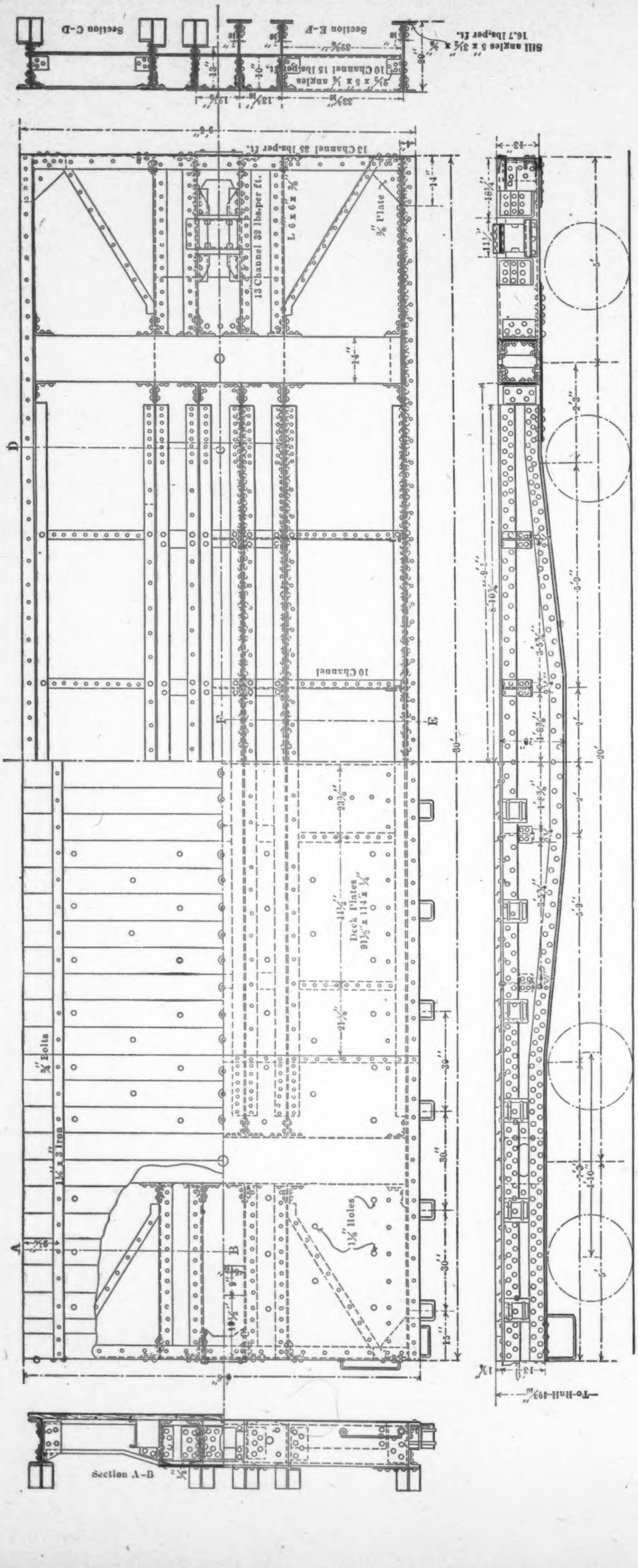
I am aware that this statement is in conflict with the experiences of many men who, having been interested in special gear, have found them to be 10, 20 and even 30 per cent. more efficient than the link motion they have displaced. A careful examination of such cases, however, will not fail to disclose the fact that the normal gear, which is made the basis of comparison, was either poorly designed, or in poor condition, and hence the results are misleading. Obviously, where two systems are involved, comparison should be based upon the best type which can be selected of each.

Valve Setting.—While somewhat apart from the purpose of my discussion, I cannot refrain from making brief reference to the matter of valve setting, for which the engraving furnishes a most admirable text. Experience both upon the testing plant and upon the road has shown that in setting valves care should be taken to avoid excessive lead at running cut-offs. Whenever the setting is such as to give a loop in the top of the card such as that which appears in the cards of the left hand column, it is safe to conclude that there is too much lead. Its reduction will increase the economy with which the engine will work at the cut-off in question. Experience also has shown that it is profitable so to reduce the lead as to avoid the loop at running cut-offs, even though there is negative lead for the longer valve travels. An examination of the cards is of interest in this connection. The cards at 15 per cent. cut-off already referred to, present too much lead, but the cut-off in question is really shorter than that at which any locomotive should be operated, and if it be assumed that these cards represent conditions which, is not impracticable, are undesirable, which is the fact, the next column of cards at 20 per cent. cut-off may be accepted as those of shortest cut-off. Here the loop has disappeared and the form of these cards may be accepted as that which attends a satisfactory degree of efficiency. With the valves thus set, it is interesting to note that at the longest cut-off of the series, namely, that of 35 per cent. stroke the lead is insufficient to sharpen the initial corner of the card, which, upon the diagram appears rounded. This, however, should create no concern, since the cards which are here presented, were obtained under conditions which have been proven to be highly efficient.—*From a paper read before the Southern and Southwestern Railway Club.*

PAPER AND PAINT FOR STEEL WORK.

An interesting experiment in the use of paraffin paper and paint to protect steel work has been going on for some time at the Jersey City station of the Pennsylvania Railroad. At the recent meeting of the American Society for Testing Materials Mr. L. H. Barker presented interesting details of this investigation. The steel work was first carefully cleaned by wire brushes and a certain kind of tacky paint was applied. The paper was then tightly pressed upon the painted surface with slightly lapping joints. Over the paper the second coat of paint may be immediately applied without waiting for the inside coat to dry. A great saving is effected by this method by necessitating but one scaffolding. The experiments have extended over three years, and are considered of too short duration to determine the value of the paper as a protection for iron and steel. They have, however, shown very satisfactory results thus far. Mr. Barker believes that the experiments prove the fact that in the case of smoke and gases corrosion begins from beneath the paint, and not from in front by the disintegration of the paint. The paper apparently prevents the access of water to the metal, and Dr. Dudley's careful experiments have shown that all paints seem to be pervious to moisture. After two years and three months exposure to smoke and gases the paper and the first adhesive coat were intact, and in places where the paper was removed for examination the adhesive coat was not yet dry, and the surface of the steel was the same as when first painted.

STEAM TURBINES IN MARINE SERVICE.—Mr. William Gray, in a paper before the Institution of Naval Architects (England), records interesting results of trials of the Midland Railway turbine steamers as compared with exactly similar ships driven by reciprocating engines. For a speed of 19.5 knots the turbine steamer saved 9.4 per cent. of coal, and at other trials the same turbine steamer saved 8.5 per cent. of coal over other vessels with reciprocating engines at a speed of 19.3 knots. Mr. Gray says: "Speaking generally, therefore, the performance of the turbine steamers, specially the 'Manxman,' have been greatly superior to those of the steamers fitted with reciprocating engines." Mr. Gray believes that the only real inferiority of the turbine vessels, which lies in the difficulty of manœuvring in narrow channels, can be overcome by increasing the backing power by making the reversing turbines more powerful. He shows the difference in the weight of machinery to be about 6 per cent. in favor of the turbines, and the difference in initial cost of the turbines as compared with the reciprocating engines 1½ per cent. of the total cost of hull and machinery.



75-TON STEEL FLAT CAR—PITTSBURGH & LAKE ERIE RAILROAD.

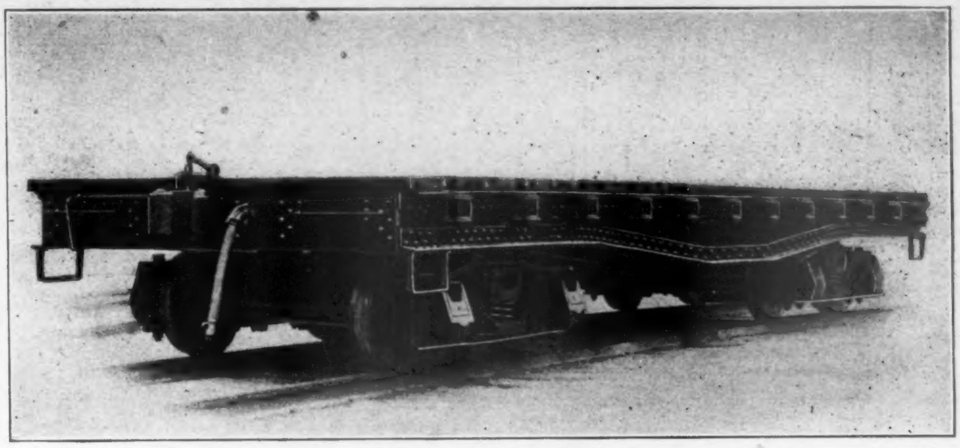
75-TON STEEL FLAT CAR.

PITTSBURGH & LAKE ERIE RAILROAD.

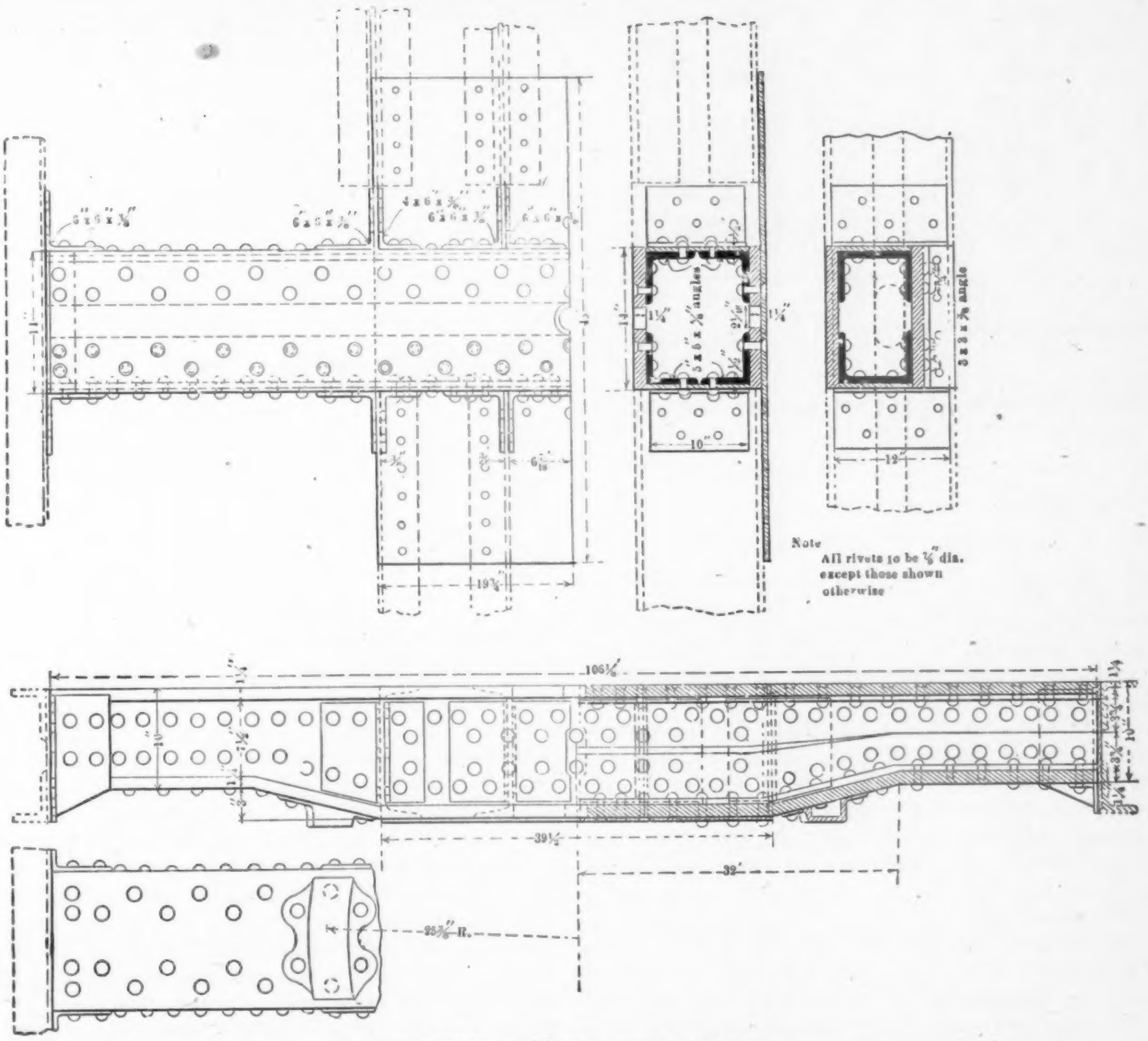
The Pittsburgh & Lake Erie Railroad has recently built at its McKees Rocks shops two 150,000-lb. capacity flat cars, which were especially designed for carrying heavy and large irregular-shaped castings. The makers and users of large castings in the Pittsburgh district were asked to furnish dimensions and weights of their largest castings, and an examination showed that the car might have to carry the greater part of the load distributed over a comparatively small space near its center, and that because of the size of some of the castings and the clearances to be observed the distance from the top of the rail to the top of the floor would have to be about 42 ins. While the car is nominally of 150,000 lbs. capacity, it is designed to carry this weight distributed over a distance of four feet at its center, and will, of course, carry safely a much greater load if distributed over a greater area. Several radical departures from ordinary steel car design will be noted. The construction is necessarily very heavy, and this is especially true of the bolsters, because of their restricted height. The light weight of the car is 48,200 lbs.

The car is 30 ft. long, 9 ft. 6 ins. wide, and the distance between truck centers is 20 ft. The body bolsters are continuous. The center and intermediate sills between the bolsters are built up of 7-16-in. plate, with two 5 x 3½ x ⅝-in angles, riveted at both the top and bottom, forming a beam of I section. The side sills are of the same construction, except that the 7-16-in. plate and the two outside angles extend the full length of the car, as shown in the drawings. The sills are 20 ins. deep for a distance of 4 ft. at the middle of the car, and taper to 13 ins. at the bolsters. The center and intermediate sills are tied together at intervals of about 4 ft. by malleable iron filling blocks, while the intermediate and side sills are tied by 10-in. channel irons. The intermediate and center sill extensions beyond the bolsters are 13-in. channels. The end sill is a 13-in. channel, and it is securely braced at its ends by the 8-in. channel braces which extend from the intermediate sills and by the ⅜-in. gusset plates at the corners of the car. The ¼-in. deck plates which cover the entire car, and are riveted to the sills, bolsters and cross-braces, add greatly to its strength and stiffness.

The body bolster is of box section, built up of plates and angles. The top and bottom members are of 1¼ x 14-in. iron, while the side plates are ½ in. thick. The four angles are 5 x 5 x



75-TON STEEL FLAT CAR.

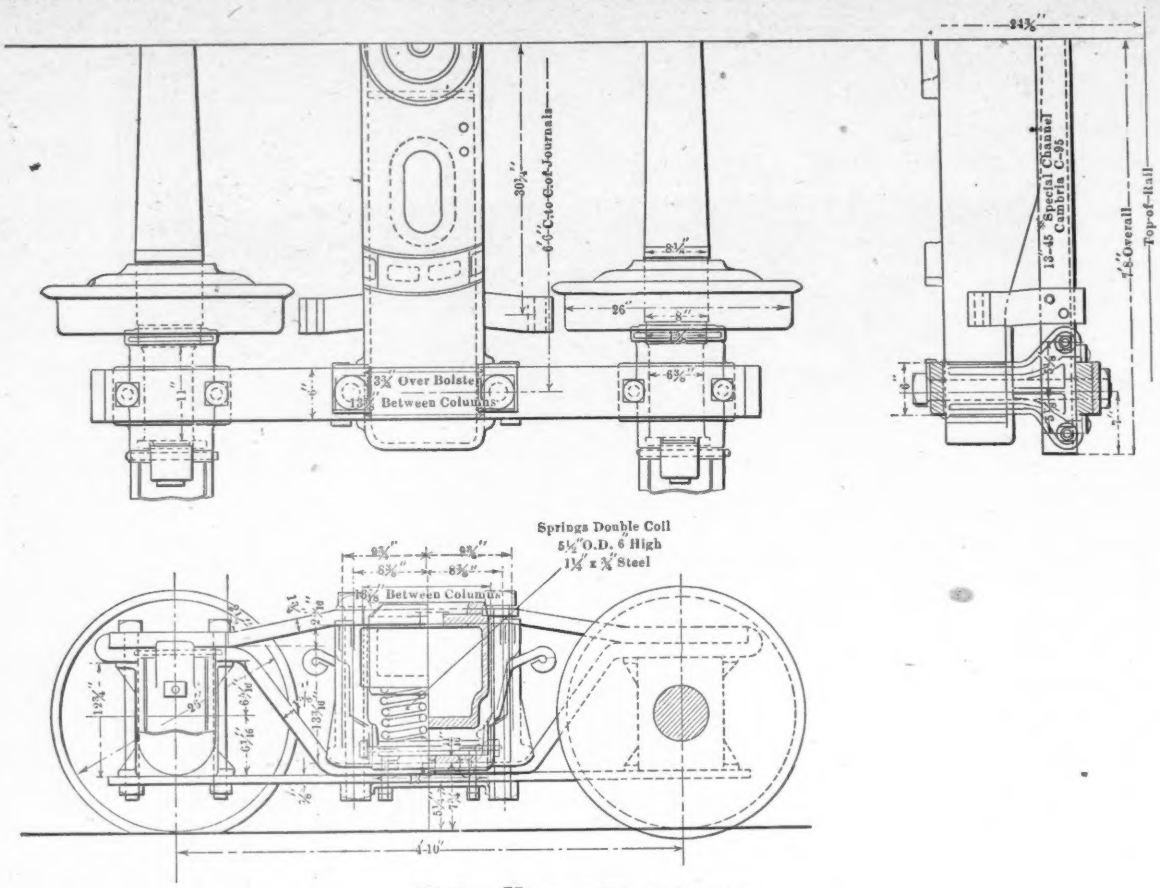


BODY BOLSTER—75-TON STEEL FLAT CAR.

⅝ ins. The bolsters are 13 ins. deep at the center and 10 ins. at the ends. The webs of the sills are securely attached to the bolsters by the heavy angles, while the flanges of the sills are riveted to the ¼-in. deck plates and the ½-in. cover plates at the bottom of the bolsters.

A 1¾-in. plank floor covers the steel plates, and is held in place by the ½ x 3-in. iron straps. The 1⅛-in. holes through the floor are for bolts or straps to hold the blocking and castings in place.

The truck is of the arch bar type, and is notable because of its heavy construction. The top arch bars are 1¾ x 6 ins., the lower ones 1⅝ x 6 ins., and the tie plates are ⅞ x 6 ins. Steel-tired wheels, 26 ins. in diameter, are used because of the low height of the car and the fact that it is necessary to reduce the truck wheel base to a minimum in order to secure the necessary strength. The truck journals are 6⅜ x 11 ins. The bolsters are of cast steel, and were designed and made by the American Steel Foundries Company. A nest of four double coil springs, 5½ ins. in diameter and 6 ins. high, supports the bolster at each end. The lower center plate and side bearings are cast integral with the bolster. The distance from the top of the rail to the top of the truck bolster is only 24⅜ ins. We are indebted for information and drawings to Mr. L. H. Turner, superintendent of motive power, and Mr. W. P. Richardson, mechanical engineer.



TRUCK—75-TON STEEL FLAT CAR.

ANGUS LOCOMOTIVE AND CAR SHOPS, MONTREAL.

CANADIAN PACIFIC RAILWAY.

VIII.

(*For previous article see page* 219.)

The grey iron foundry is 122 by 342 ft., and is located near the locomotive shop, with one end against the midway. This building provides a central floor with a crane span of 57 ft., served by a 10-ton crane. The central portion has a clear height of 29 ft. under the roof trusses, and the lower faces of the crane runways are 20 ft. above the floor. The two wings are 30 ft. wide and 16 ft. high. As shown in the plan, one wing provides for a chipping and tumbler room, an office, pattern storage, rooms for blowers, sand and facing; and the other for the cupolas, four core ovens and core room, and a large space for the flask maker. The cupola room has a second story with a heavily constructed platform, which constitutes the charging floor. This floor is extended into the yard, a distance of 14 ft. 6 ins., connecting with a platform upon which the out-of-door crane delivers pig iron and coke. This yard crane has a span of 60 ft. and reaches the stock piles. The engravings show the plan of the foundry, and section and the plan of the charging room. This building provides a total ground area of 42,475 sq. ft., and has a capacity for 50 tons daily. One of the engravings illustrates the interior of the building, showing the central portion, where the heavy work is done. This view was taken looking toward the midway. It shows two of the core ovens at the left. A monitor with a glass roof extends the full length of the building, and in addition to this an upper row of windows over the crane runways gives an unusual amount of light for a foundry. The ultimate capacity of this foundry is to be 75 tons per day.

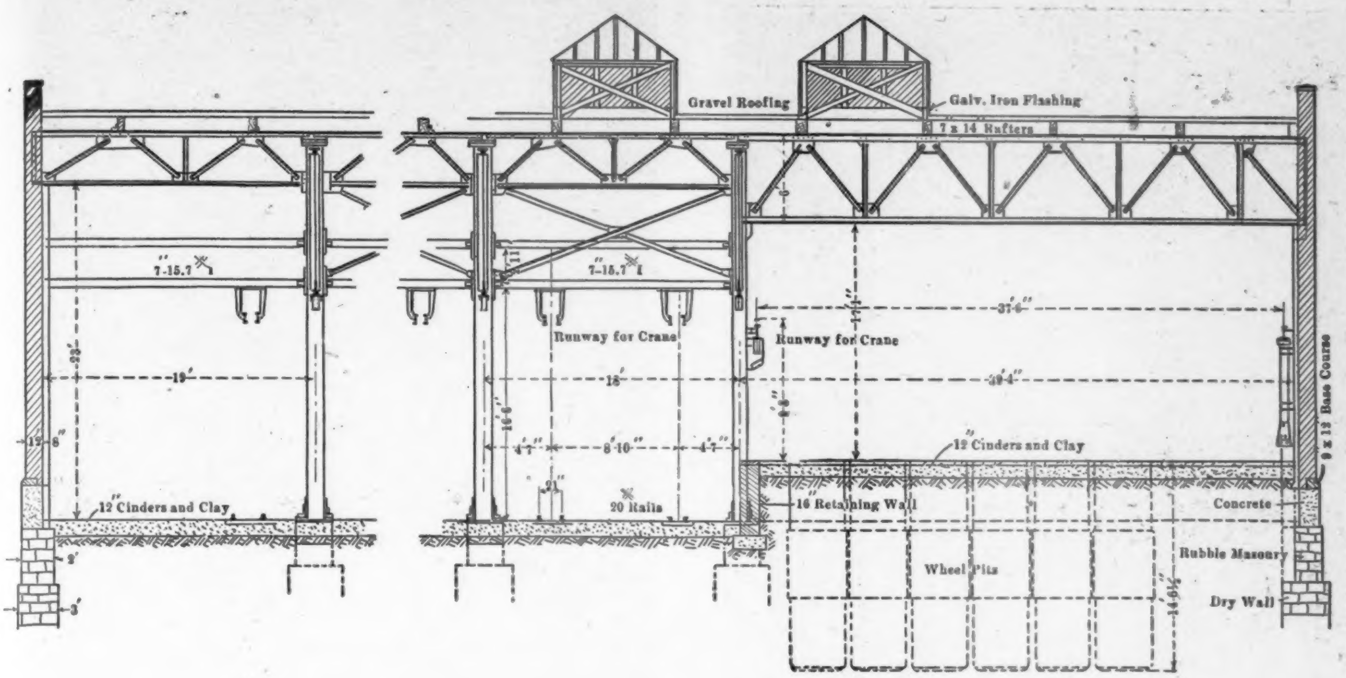
GREY IRON FOUNDRY EQUIPMENT.

No. 9½ Whiting cupola.
No. 7 Whiting cupola.
No. 7 Root blower.
Two truck ladles for slag; capacity, 1,500 lbs.
One 9 by 14 by 8 ft. 6 ins. core oven.
Three 9 by 18 by 8 ft. 6 ins. core ovens.
Four core oven cars, 6 by 8 ft.
Four core oven cars, 5 by 6 ft.
Twelve charging cars, 3 tons capacity, 24 ins. gauge.
Two 48-in. turn-tables for charging platform.
Two dump buckets, 4 ft. 6 ins. diameter by 4 ft. deep for yard crane.
One 3-motor travelling crane, 10 tons capacity, for foundry.
One 3-motor crane, 10 tons capacity, for yard.
One 2-motor 3-ton crane, for core room.

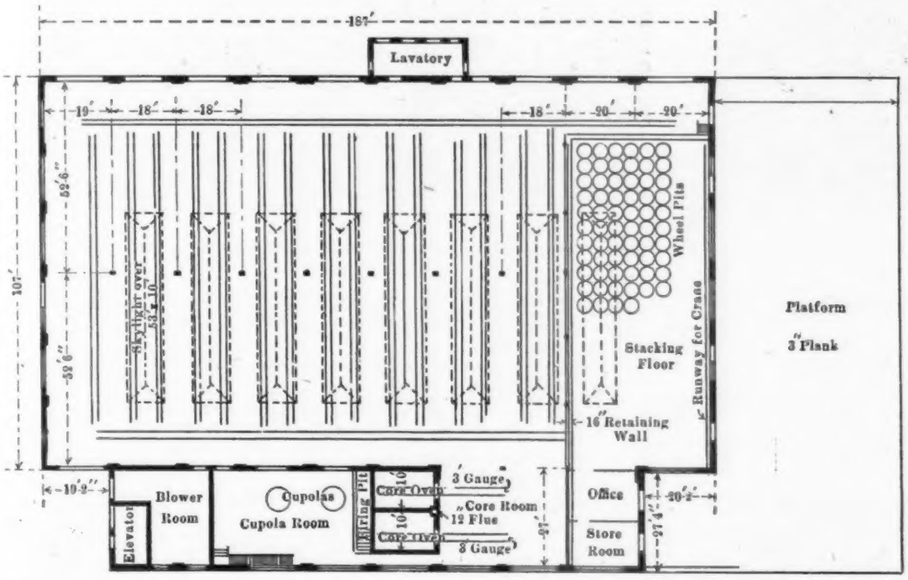
WHEEL FOUNDRY.—This foundry is conveniently arranged and located near the freight car and truck shops. It is 107 by 187 ft. in size, and divided into three transverse sections. The cupolas are in a room 90 ft. long by 27 ft. wide, with the charging floor above. This building covers an area of 24,516 sq. ft. At one end the annealing pits and storage spaces are provided for with a floor 4 ft. above that of the molding floor. From this a 1½-ton electric crane, with a span of 37 ft. 6 ins., covers the entire area. The molds are placed in transverse rows with a travelling hoist over each row, and at the end of the rows of molds narrow-gauge tracks carry the ladles from the cupola. This foundry was built for a capacity of 300 wheels per day, which are poured on fifteen floors of twenty wheels each. Two cupolas are provided for use alternately. The hot wheel cars are arranged in a train of four to receive the wheels at the lower end of the floors when transported by the transverse travellers. The wheel breaker and stock are in the rear of the building, convenient to the elevator reaching the charging floor. The line engravings show a longitudinal section and plan and the interior view of this foundry. A small detail drawing shows the runway hangers for the carriers and molding floors.

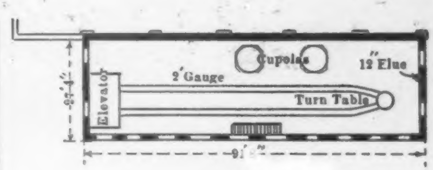
EQUIPMENT FOR THE CAR WHEEL FOUNDRY.

Fifteen belted floor carriers.
Two 8-ton reservoir ladles, with D. C. motor and controller.
Four ladle trucks making a train.
One puller machine for ladle transfer.
Ten pouring ladles, 800 lbs. capacity.
One puller machine for wheel transfer, D. C. motor and controller.
Four wheel trucks, a continuous train.

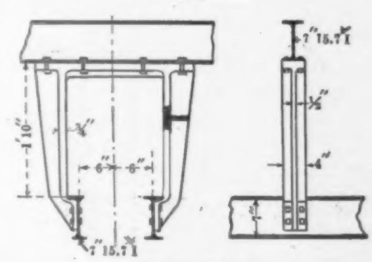


LONGITUDINAL SECTION THROUGH WHEEL FOUNDRY.



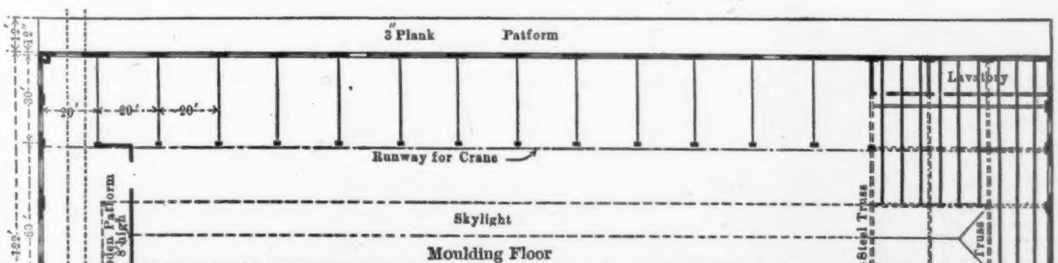


Charging Floor

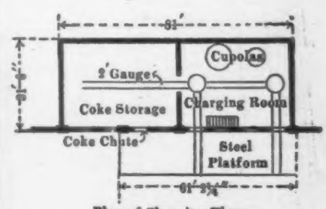


Runway Hanger

FLOOR PLAN OF WHEEL FOUNDRY.



GROUND PLAN OF GREY IRON FOUNDRY.

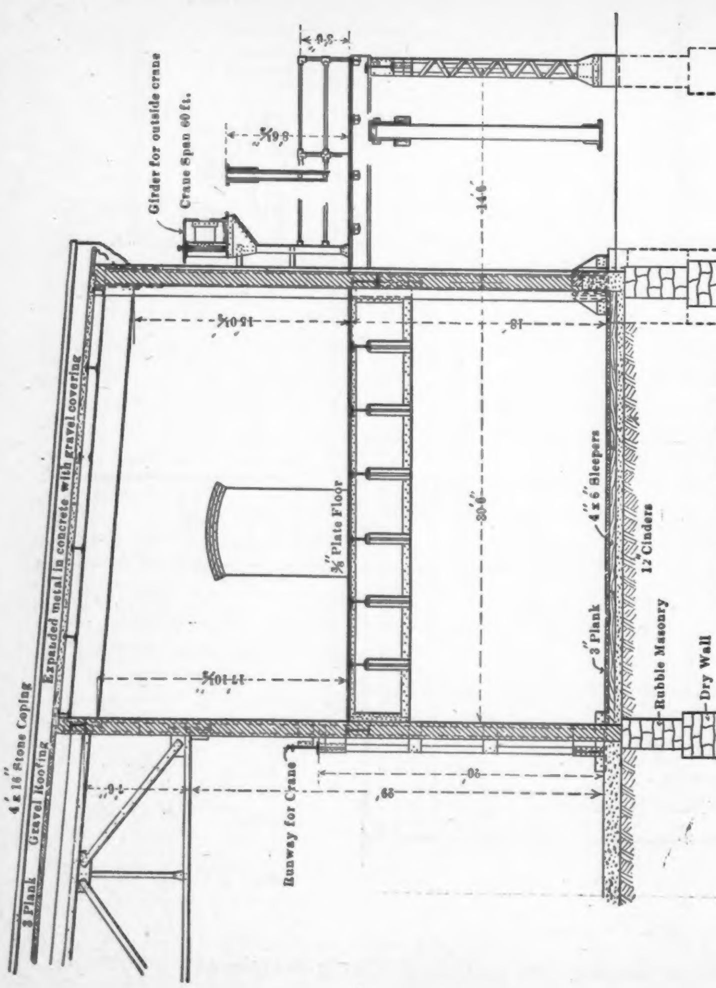


Plan of Charging Floor

GREY IRON AND WHEEL FOUNDRIES, ANGUS SHOPS, CANADIAN PACIFIC RAILWAY.

GENERAL VIEW IN WHEEL FOUNDRY.

GENERAL VIEW IN GREY IRON FOUNDRY.



CROSS-SECTION OF GREY IRON FOUNDRY.

One 3-motor D. C. electric pitting crane.
Sixty-four annealing pits for 20 wheels each.
No. 9½ Whiting cupola.
Two core ovens, 9 by 15 ft.
Four core oven cars.
No. 7 Root blower, direct connected with D. C. motor.
Ten 48-in. turn-tables.
Twenty 3-ton trucks.
Pneumatic wheel breaker.
One double cage 3-ton electric elevator.

The floor cranes are of 1,500 lbs. capacity, running upon tracks 106 ft. long. A line shaft furnishes power for the hoisting machine, the gearing of which is operated by straight and cross belts, the travellers being fitted with ½-in. wire rope. The lift is 12 ft. The travelling gearing is located near the hoisting gearing, and attached to the trusses, the mechanism being reversible, consisting of friction gearing, driving and curved face friction drums, which carry the endless pulling rope attached to the trolley. The reverse movements of the trolley are obtained by setting the friction wheel against either of two friction pulleys. The trolleys have cast iron frames and run on I beam tracks, as shown in the engraving. The ladle trucks have structural steel frames large enough for two 800-lb. ladles. These trucks are connected together to form a continuous train, and are used for carrying molten metal across the front of the floor. This train is operated by a puller machine, which is driven by a motor. The wheel trucks have cast steel frames, arranged to receive the hot wheels in an inclined position from the floor cranes. The pitting crane is fitted with a special trolley, having two hoisting blocks and arranged to handle two wheels at a time. The annealing pits are of tank steel, with 3-16-in. sides and heads. Equipment for this foundry was furnished by the Whiting Foundry Equipment Company, Harvey, Ill.

ATLANTIC TYPE PASSENGER LOCOMOTIVE, WITH SUPERHEATER.

CHICAGO, ROCK ISLAND & PACIFIC RAILWAY.

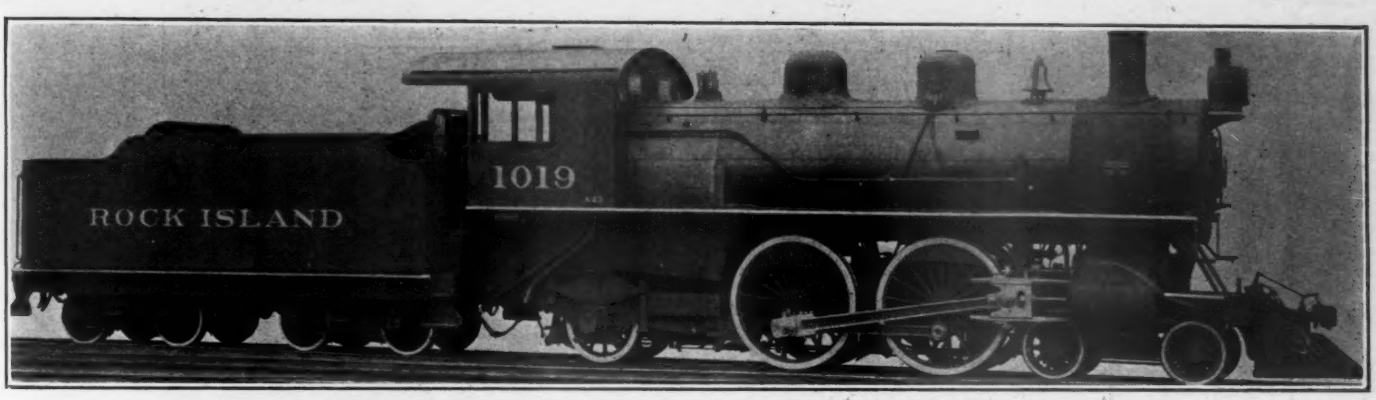
The proposed standard locomotives recommended by the power committee of the Rock Island System were presented in outline in this journal in March of this year, page 84. On page 282 of the August number the Pacific type passenger locomotive was illustrated.

Ten Atlantic type passenger locomotives have been built by the Schenectady works of the American Locomotive Company, one of which is shown in the accompanying photograph. Two of these are equipped with Cole superheaters. These locomotives are for fast passenger service, and are similar to earlier ones which have been running very successfully on the Chicago & Eastern Illinois. After the completion of certain grade reductions the present driving wheels may be replaced by 79-in. wheels. These locomotives have 12-in. piston valves, straight boilers, deep fireboxes and rigid trailer trucks with outside journals. The superheater has a heating surface of 338 sq. ft. in 54 3½-in. tubes. The leading dimensions are as follows:

ATLANTIC TYPE PASSENGER LOCOMOTIVE WITH SUPERHEATER.

CHICAGO, ROCK ISLAND & PACIFIC RAILROAD.

GENERAL DATA.	
Gauge	4 ft. 8½ ins.
Service	Passenger
Fuel	Bituminous coal.
Tractive power	24,700 lbs
Weight in working order	185,000 lbs.
Weight on drivers	104,100 lbs.
Weight of engine and tender in working order	323,850 lbs.
Wheel base, driving	7 ft.
Wheel base, total	27 ft. 5½ ins.
Wheel base, engine and tender	57 ft. 1½ ins.
RATIOS.	
Tractive weight ÷ tractive effort	4.2
Tractive effort x diam. drivers ÷ heating surface	754
Heating surface ÷ grate area	53.3
Total weight ÷ tractive effort	7.49
CYLINDERS.	
Kind	Simple, piston valve.
Diameter and stroke	21 by 26 ins.
Piston rod, diameter	3¾ ins.
VALVES.	
Kind	Piston.
Greatest travel	6 ins.
Outside lap	1 in.
Lead	¼ in. at ¼ stroke.
WHEELS.	
Driving, diameter over tires	73 ins.
Driving, thickness of tires	3½ ins.
Driving journals, main, diameter and length	9½ by 12 ins.
Engine truck wheels, diameter	33 ins.
Engine truck, journals	6 by 12 ins.
Trailing truck wheels, diameter	45 ins.
Trailing truck, journals	8 by 14 ins.
BOILER.	
Style	Straight top.
Working pressure	185 lbs.
Outside diameter of first ring	72 ins.
Firebox, length and width	96 by 67 ins.
Firebox plates, thickness	⅜ and 9-16 in.
Firebox, water space	4½ ins.
Tubes, number and outside diameter	173, 2-in.; 54, 3½-in.
Tubes, gauge and length	11, 16 ft. long.
Heating surface, tubes	2,227 sq. ft.
Heating surface, firebox	162 sq. ft.
Heating surface, total	2,389 sq. ft.
Superheater heating surface	338 sq. ft.
Grate area	44.8 sq. ft.
Exhaust pipe	Single, 5⅛ ins.
Smokestack, diameter	18 ins.
Smokestack, height above rail	15 ft. 1½ ins.
Centre of boiler above rail	108 ins.
TENDER.	
Tank	Water bottom.
Frame	13-in. channels.
Wheels, diameter	36 ins.
Journals, diameter and length	5½ by 10 ins.
Water capacity	7,000 gals.
Coal capacity	12 tons.



ATLANTIC TYPE PASSENGER LOCOMOTIVE—CHICAGO, ROCK ISLAND & PACIFIC RAILWAY.

COST OF POWER.

The following figures are taken from a paper on "Gas as a Motive Power and Its Relative Cost," read before the Canadian Society of Civil Engineers by Mr. W. H. Laurie. Considering the cost of fuel only, the relative cost per brake horse-power per annum of power developed by gasolene, steam and gas engines is as follows:

Gasoline engine	78.00
Illuminating gas with modern gas engine	46.80
Steam engine	37.44
Semi-water gas from anthracite coal	7.80
Semi-water gas from gas coke	5.74
Water and producer gas (bituminous coal)	5.00

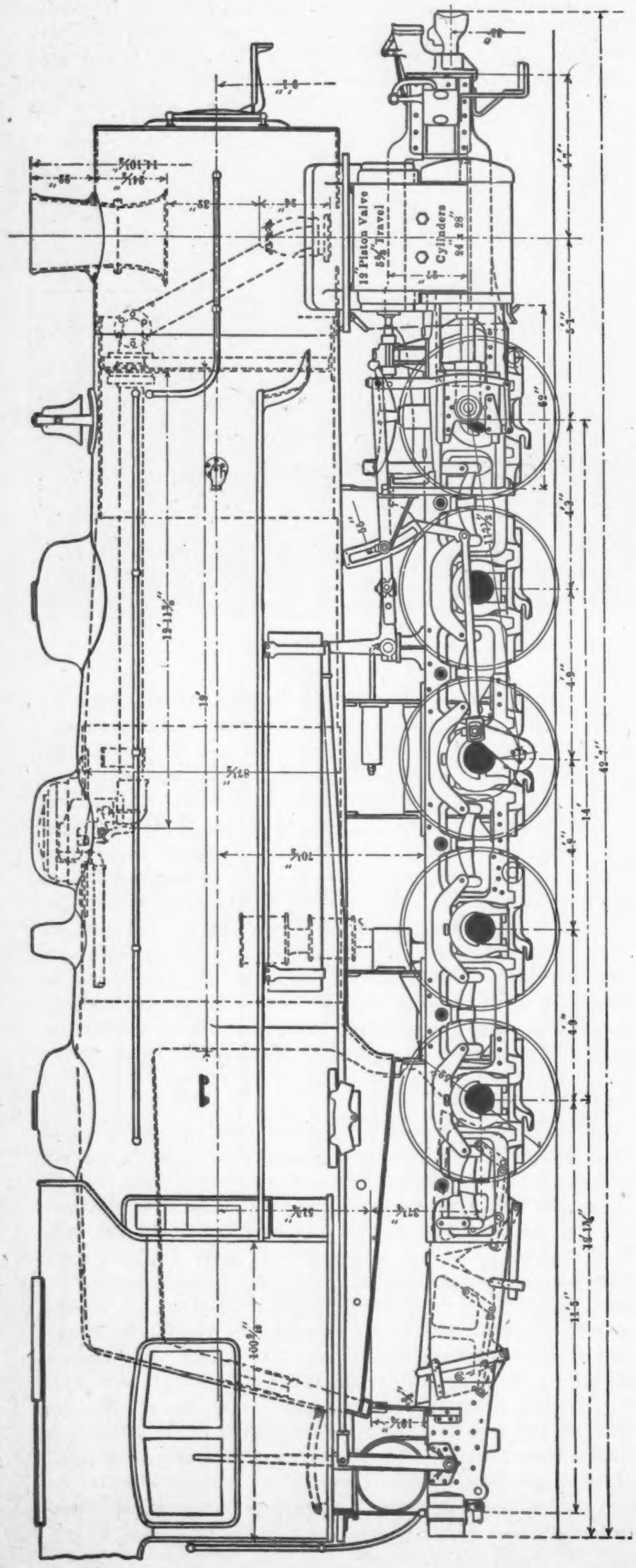
These figures are based upon the following assumptions: A year is taken as 312 days of 10 hours each; one-eighth of a gallon of gasolene is required per b.h.p hour at 20 cents per gallon; an average of 15 cu. ft. of illuminating gas is required per b.h.p. hour at $1 per 1,000 cu. ft.; an average of six pounds of coal is required per b.h.p. hour with automatic high pressure steam engines of small powers with coal at $4 per ton; semi-water gas from anthracite coal will develop a b.h.p. on one pound of coal in the generator with coal at $5 per ton; semi-water gas from gas coke will develop a b.h.p. hour on .92 lbs. of coke at $4 per ton; water gas with plants of 500 h.p., and over will produce a b.h.p. on .80 lbs. of bituminous coal at $4 per ton. The water gas system is especially adapted for large power plants and except under special conditions is of greater capacity than required for small units.

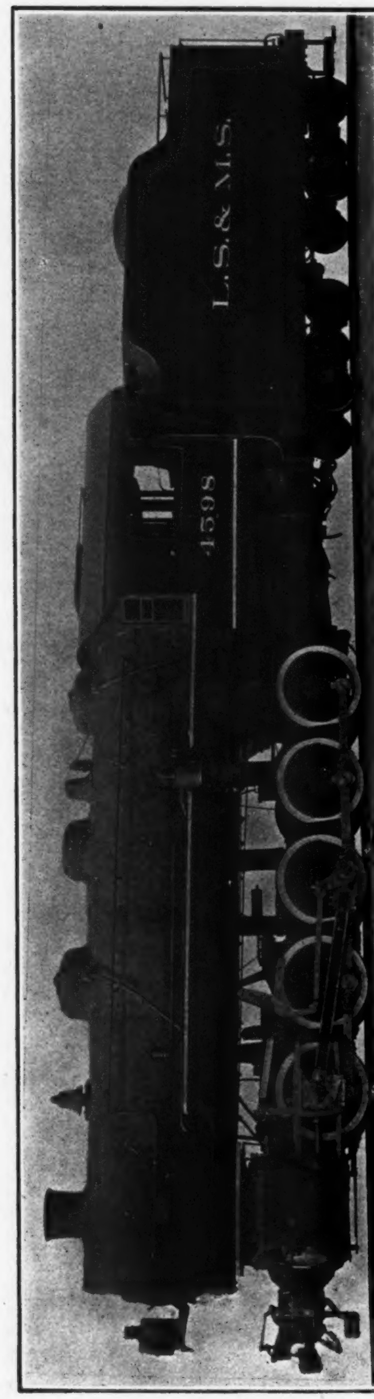
USELESS SPECIALTIES.—If you glance round at the work of some of our big men, you will be surprised to see how many have made their reputation by doing one small thing, but doing it well. If a man gets to the front in one narrow subject, the world credits him with knowledge of all the rest. It is, however, even easier to acquire a large general knowledge than an advanced special knowledge of one narrow subject. The specialty must not be too narrow either. I remember a Scotchman applying for an opening. He had no knowledge of electrical work, but thought it was easy to become an electrician. I suggested he had better stick to his own line, in which he admitted he was really at the top of the tree. He said, unfortunately, eminent as he was in it, there was just then no opening. His specialty was "Turneep anawlysis." He could analyze a turnip better than anyone else in the country, but no one wanted any turnips analyzed.—*J. Swinburne.*

HEAVY SWITCHING LOCOMOTIVE.

NEW YORK CENTRAL LINES.

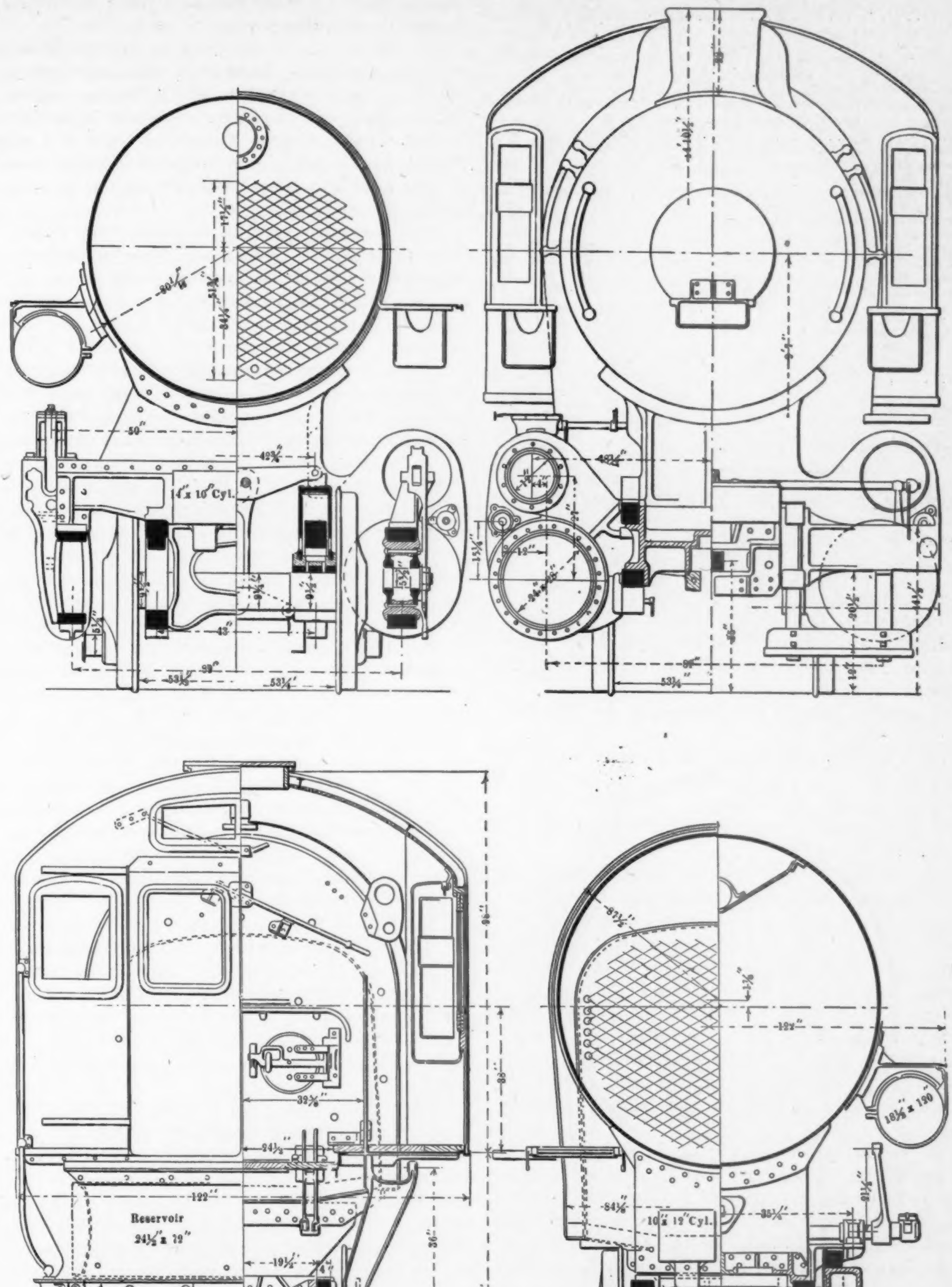
For hump yard service on the Lake Shore two ordinary locomotives have been required to handle trains over the summits in switching. To provide in a single engine the great tractive power required for this work the American Locomotive Company has built, at the Brooks Works, a number of the heaviest and most powerful switching locomotives ever constructed. Two of these are used in the hump yard at Elkhart, two at Collinwood and one is used in pusher service on the grade westbound out of Cleveland. The grades in the hump yards are from 0.67 to 2.00 per cent., and the grade out of Cleveland is 39 ft. per mile. One of these locomotives is intended to handle as heavy a train as can be hauled into the yard by the heaviest road engines. With a tractive effort of 55,300 lbs., a total weight of 270,000 lbs., cylinders 24 x 28 ins. in diameter and a total heating surface of 4,625 sq. ft., these locomotives take a high place among the largest in use. All of the weight is upon the driving wheels, which are 52 ins. in diameter, and a very large boiler is required for supplying steam to these large cylinders when working full stroke. In





POWERFUL SWITCHING LOCOMOTIVE—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

the matter of details, the $4\frac{1}{4}$-in. piston rods, 6-in. frames and unusually heavy bracing across the frames, are worthy of note. These locomotives are fitted with Walschaert valve gear, which was adopted in this case for convenience in accessibility. The general dimensions of the design are presented in the accompanying table:



POWERFUL SWITCHING LOCOMOTIVE—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

HEAVY SWITCHING LOCOMOTIVE.—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

GENERAL DATA.

Gauge	4 ft. 8½ ins.
Service	Freight.
Fuel	Bituminous coal.
Tractive power	55,300 lbs.
Weight in working order	270,000 lbs.
Weight of engine and tender in working order	419,600 lbs.
Wheel base, driving	19 ft.
Wheel base, engine and tender	54 ft. 5½ ins.

RATIOS.

Tractive weight ÷ tractive effort	4.8
Tractive effort x diam. drivers ÷ heating surface	622
Heating surface ÷ grate area	84
Total weight ÷ tractive effort	4.8

CYLINDERS.

Kind	Simple
Diameter and stroke	24 by 28 ins.
Piston rod, diameter	4¼ ins.

VALVES.

Kind ....12-in. piston.
Greatest travel....................5⅝ ins.
Outside lap....................1 in.
Valve motion.................... Walschaert.

WHEELS.

Driving, diameter over tires....................52 ins.
Driving journals, main, diameter and length....................10½ by 12 ins.

BOILER.

Style ....Radial wagon tcp.
Working pressure....................210 lbs.
Outside diameter of first ring....................80 1-16 ins.
Firebox, length and width....................108 by 73 ins.
Firebox plates, thickness....................⅜ and ½ in.
Firebox, water space....................4½ ins.
Tubes, number and outside diameter....................447, 2-in.
Tubes, gauge and length....................11, 19 ft. long.
Heating surface, tubes....................4,422 sq. ft.
Heating surface, firebox....................203 sq. ft.
Heating surface, total....................4,625 sq. ft.
Grate area....................55 sq. ft.
Exhaust pipe .... Single.
Smokestack, diameter.................... 20 ins.
Smokestack, height above rail....................14 ft. 10½ ins.
Centre of boiler above rail....................109 ins.

TENDER.

Tank ....Water bottom.
Frame ....13-in. channels.
Wheels, diameter ....33 ins.
Journals, diameter and length....................5½ by 10 ins.
Water capacity ....8,000 gals.
Coal capacity ....12 tons.

THE NEW PENNSYLVANIA DYNAMOMETER CAR.

By W. O. Dunbar.

The car, as a whole, is of special design throughout, and is carried on two 4-wheel trucks. The trucks are of new design, necessitated by the form of construction of the underframe of the car. The main features, however, are three, the dynamometer being on the hydraulic principle:

First—The drawbar and its attachments to the hydraulic cylinder.

Second—The weighing mechanism and transmission of the pressure to give the necessary movement of the pen, which is to indicate the amount of the pull.

Third—The paper diagram driving mechanism and the connection to the axle of the car.

In this order it may be said that the underframe of the car is completed, being made excessively strong. The central portion of it consists of a heavy steel plate box girder 21 ins. deep by 38 ins. wide, extending 51 ft., the entire length of the car, forming a practically dustproof and water-tight housing for the drawbar and its attachments.

This drawbar is to be 20½ ft. long from the front end of the coupler to the rear end of the hydraulic piston. The piston is 8 ins. long by 16¼ ins. in diameter, with piston rods at either end 6 ins. in diameter, and fits the cylinder with the greatest possible accuracy to work without friction and without packing.

The drawbar, at the coupler end, is made up with a standard automatic coupler and Westinghouse friction draft gear, as in our standard freight cars, but caged in a rectangular, boxlike steel casting, which is open at the front end only and large enough inside to allow free room for the side play of the coupler at the open end and for the cushioning action of the inclosed draft gear. This particular steel casting may be called the coupler cage. The rear end of the coupler is pivoted to the front end of the draft gear to allow the side play referred to. The rear end of the coupler cage is rigidly connected to the drawbar proper, forming a part of it.

The remaining important feature of the drawbar consists of a nest of helical buffer springs confined in a strap under a compression load of 100,000 lbs. in such a manner as to form a continuous and rigid portion of the drawbar under all pulls up to 100,000 lbs., the maximum capacity expected to be recorded by the weighing mechanism; but when a pull or push greater than 100,000 lbs. is exerted by shock or otherwise, the drawbar stretches or contracts by means of a still further compression of these springs. This is to prevent undue strain being put on the piston and cylinder, which, however, are capable of standing a much heavier load without injury.

From this it will be seen that the drawbar altogether is a pretty massive piece of apparatus. Great pains have been taken to support this drawbar, as a whole, so that for any pull or push it will move practically frictionless.

The coupler cage is supported by six circuitous groups of hardened steel balls, 32 balls in each; two groups beneath, two above and one group on either side, each group giving a bearing over a foot in length. Ten balls of each group, 60 in all, are always in supporting contact with the coupler cage. These balls are each 1¼ ins. in diameter, and so exactly guided in their races that there is no likelihood of their binding one against the other.

While the coupler has all necessary play within the cage, the cage itself is to be so neatly fitted between the groups of balls that it has practically no side play.

At the other end, as near to the piston as practicable, the drawbar is surrounded and supported by a nest of small balls in a short cylindrical case, which in turn is held in a bushing, so that the nest rolls longitudinally back and forth in its bushing and along the drawbar as the latter moves, but is prevented from creeping along the bar more than 1¼ ins. either way by the end walls of the surrounding bushing.

The drawbar is made 5 ins. in diameter for a considerable portion of its length from the point where it connects to the coupler cage to provide ample stiffness; but to further prevent any tendency to sagging, there is located between the 100,000-lb. buffer springs and the coupler cage another specially constructed bearing consisting of two rollers, each acting as a support at an angle of 60 deg. with the vertical and turned to an exact radius equal to the distance to the supporting surfaces. These two rollers are pivoted to the drawbar with roller journals and prevented from sliding by being provided with accurately cut teeth, on the outer edge, which mesh with the rack along the edge of the supporting surface.

Buckling from any shock is prevented by cylindrical bushings or guides, through which the drawbar passes without friction, and at the same time without lost motion. Moreover, when the dynamometer is not in service the coupler cage is locked by blocking specially provided, preventing any load from reaching the drawbar beyond the coupler cage.

The longitudinal motion of this cage, when not locked, is the same as that of the piston and drawbar proper, and is in the direction of the pull along the center line of the car, and for any pull under 100,000 lbs., were there no leakage, would never amount to more than .3 of an inch, but in case of shocks or leakage a total motion of 2.8 ins. (1.4 ins. either way from the central position) is allowed for. This excessive motion will be but temporary in any case, as a leakage pump is to be provided to automatically adjust the piston to its central position.

Since the coupler cage as described has no side play to speak of and so little longitudinal motion, it becomes a comparatively easy matter to completely seal the drawbar as a whole within the box girder of the underframe, to keep out dust and protect the ball bearings from rust, by simply inserting a strip of packing around the outside surface of the coupler cage between it and the closely surrounding surface of the steel casting which forms the opening in the end of the box girder through which the coupler cage protrudes.

It may be noted here that the box girder described is made deeper for a distance at the point where the piston is located, and also at the 100,000-lb. buffer springs, to provide more room for these parts and for getting at them, which will be done from manholes in the car.

The effective area of the drawbar piston is to be 181.12 sq. ins. The movement of the dynamometer pull pen at full capacity is to be 10 ins. Thus, to get the 10 ins. motion, that of the drawbar will be multiplied practically 36 times at the recording cylinder. The pull pen is attached to the end of the piston rod of the recording cylinder, which is 40 ins. long inside and 2 27-32 ins. in diameter, having the effective area of 5.032 sq. ins.

The recording piston is 26 ins. long over all, and midway of its length consists of a 2-wheel carriage 18 ins. long, which carries the weight of the piston. The two carriage wheels are of very nearly the same diameter as the piston itself, the two

ends of the piston being each 4 ins. long and the closest possible fit in the cylinder, so as to work without packing and with a minimum of leakage and friction.

The pressure is transmitted from the front or back head of the drawbar piston, according as the force at the drawbar is a pull or a push, to but one end of the recording cylinder, and all oil which leaks past either piston is carried back to the supply and used again without being allowed to offer any back pressure against the pistons. From this it will be seen that, whether pull or push, the "pull" pen travel is all on one side of the zero or base line. The indication of a pull or push is to be recorded on the diagram just as in the present car, as described in the paper, but by means of a device which depends on the fact that, in changing from a pull to a push or the reverse, the hydraulic check valves in the drawbar cylinder are not reversed until the drawbar piston has been moved to the other side of its central position by 1-16 of an inch; that is to say, all pull records will be taken while the drawbar piston is from 1-16 to 1 3-16 ins. forward of its central position, and likewise all push records when at a like distance to the rear of its central position.

The measurement of the amount of pull or push exerted on the drawbar piston is accomplished by means of helical springs, of known calibration, introduced symmetrically around the outside of the recording cylinder to resist the motion of the piston rod of the same. For the full capacity of 100,000 lbs., since the motion is multiplied 36 times, the total resistance to be offered by the helical springs referred to is one thirty-sixth (1-36) part of 100,000 lbs., or 2,778 lbs. Now, if we suppose that there are six of these helical springs in the nest, all alike spaced 60 deg. apart around the piston rod, each spring would have a load on it of 463 lbs. when there is a load of 100,000 lbs. on the drawbar, and consequently when the springs are compressed the full 10 ins.

If, now, it is desired to make the capacity but 50,000 lbs. for the 10 ins. motion, it can be done by removing every other one of the six, leaving three springs spaced 120 deg. apart. Again, if 33,333 lbs. is the desired total capacity, it can in like manner be had by removing four of the springs, leaving any two diametrically opposite. And, again, by removing any one pair of springs which are diametrically opposite each other, the four springs remaining will have a capacity for the 10 ins. of 66,667 lbs., so that the total capacity of the dynamometer could be made 33,333 lbs., 50,000 lbs., 66,667 lbs., or 100,000 lbs., as desired, or per 1 in. of ordinate one-tenth of these amounts.

From this it will be clear if, instead of making all the six resistance springs alike, they be made in pairs, but each pair of a selected stiffness, it is possible to have, in all, seven different dynamometer capacities from but three pairs of springs. For instance, if one pair is made to give a total capacity of 10,000 lbs., or 1,000 lbs. per inch of ordinate, another pair for 30,000 lbs., or 3,000 lbs. per inch, and the third pair for 60,000 lbs. or 6,000 lbs. per inch, the possible combinations as above explained will give any of the following seven capacities: 10,000, 30,000, 40,000, 60,000, 70,000, 90,000 and 100,000 lbs., or per inch of ordinate one-tenth of these amounts.

By providing an additional pair or so of these resistances, it is possible to conveniently have any capacity or scale that may be desired, depending on the nature of the work to be done. Furthermore, it is not absolutely necessary in all cases to entirely remove the springs in changing from one capacity to another, for any one or more of the resistances may be compressed solid while in position, so as not to be included in the resistance to the motion of the recording piston, when pressure is applied to the recording cylinder from the drawbar piston.

The hydraulic apparatus or dynamometer proper, including the method of applying the resistance springs, just described, is the design of Mr. Albert H. Emery, of Stamford, Conn., who is also the designer and patentee of the weighing mechanism of the present dynamometer car.

The description which has been given in the paper, of the recording mechanism of the present car, will serve to give a general idea of what will be employed in the new one. The motion, however, will be taken from the axle by a screw gear. Since the axle has a motion in all directions relative to the car body, preventing the use of a fixed shaft, two Hooke's (Universal) joints are included in the line of shafting connecting the screw gear and the mechanism to be driven. These joints, as well as the shaft, are made of a new design, with a view to insuring that they will run in perfect balance at high speeds.

In addition to the recording pens mentioned in the paper, there will be one to lay off a mark every 1,000 ft. traveled; by counting the number of spaces thus laid off, the distance between any two points located, or the total distance run, can be promptly determined from the diagram within a small fraction of 1 per cent. Another advantage of this automatic distance spacer is that it provides a means for correction if the paper shrinks or as the wheels on the axle from which the motion is taken wear.

There will also be one spare pen. With the datum pen and pull pen there will be, in all, ten recording pens.

The travel of the paper will be the same as in the present car—52.8 ins. per mile, or 1 in. per 100 ft. The width of the paper diagram has been increased from 14¾ ins. to 18 ins., mainly because of the greater travel of the pull pen, due to the greater capacity of the car. In fact, it is because the 28,000 lbs. capacity of the present car, sufficient 20 years ago, is only 28 per cent. of the capacity thought necessary to provide for to-day that the new car is being built.

Descriptions with drawings which have been published recently by *The Railway Age*, *Railroad Gazette* and American Engineer and Railroad Journal, of the locomotive testing plant exhibited by the Pennsylvania Railroad at the St. Louis Exposition, will be found valuable in this connection to those interested, as the recording mechanisms in the two cases are very similar.

The car will be lighted by electricity by means of a 5 by 6-in. De la Vergne Machine Company vertical oil engine, with direct connected dynamos, in connection with a storage battery, which will also be the means of operating the leakage pump and the eight electric circuits to the dynamometer pens. There will also be sleeping accommodations for eight men, with some other conveniences, including room for a kitchen.

This description was given by Mr. Dunbar in a discussion before the Engineers' Club of Philadelphia.

Definition of "Engineer."—In the charter of the Institution of Civil Engineers the engineer is defined as "Directing the great sources of power in Nature for the use and convenience of man." With all respect to this august body, and their often-quoted definition, I would humbly suggest that it is bad. It is really the definition of a scientific man. It is incomplete as applied to an engineer, because it does not take into account the sordid element of price. An American definition is much better: "An engineer is a man who can do for one dollar what any fool can do for two." This is not poetical, and is useless for oratorical purposes; but it is right. It is no use being able to design most complicated alternating current machinery, or being able to explain it with the help of a wilderness of clock faces and several issues of the technical journals, unless the machine, when made, is cheaper than its rivals. Every design, every engineering manufacture, and every piece of engineering is only a question of price. It is unpleasant, perhaps, but it is a hard fact, and we have got to face it.—*J. Swinburne.*

The Value of Difficulties.—Though you may not like it, a hard struggle is very good for a young man who has anything in him. It gets him into the way of overcoming difficulties, so that when he gets above the small obstacles he goes on overcoming large ones from the mere force of habit. Nearly all great men rise from almost nothing, with infinite trouble in their youth.—*J. Swinburne.*

(Established 1832).

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Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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A machine tool representative going the rounds of his customers called on a shop superintendent. Answering a question as to what degree of satisfaction a certain new machine was giving, the superintendent said: "That machine is disappointing. It is out of service more than any other in the shop and it is continually breaking down. The men do not like it. I wish you would take it back."

Having permission, the machine tool representative sent a man to ascertain the facts. Being diplomatic and himself an expert workman, the man immediately saw what was wrong. The foreman sent around stock for an ordinary day's run. The man turned up 45 pins, using up the stock, and asked for more. When the piece work inspector looked up the time, it was found that the job had been done in one-quarter of the basis piecework time. Instead of putting the machine back into the hands of the builders, more of them were ordered. This machine narrowly escaped sacrifice because of its excellence and yet the shop superintendent was perfectly sincere. This illustrates the great importance of absolutely reliable information concerning the capabilities of machine tools. It costs money to know what tools will do, but if, by knowing, you may double or quadruple your output, will it pay?

The writer has discovered the difficulty with compounds, and it is too good to keep. It was revealed on a road where compounds are in disfavor and are being changed over into "simples." A traveling engineer (who understood his business) was hired from another road and the very first engine he rode on was a compound. He asked the engineer how the engine worked. The engineer replied, "First rate." The traveling engineer noticed that the starting valve was open and waited for the engineer to close it, as the engine was up to speed, but the valve was not touched. This led to the question, "Are you working as a simple or a compound?" The answer was, "I don't know." "How long have you been running these compounds?" "Eight years." "Do you not use that valve?" "No, I always leave it as it is now." "Even when running fast as you are now?" "Yes." This man had run a compound locomotive in freight service for eight years and did not know the object of the starting valve. He had always kept it "open."

It is not wonderful that compounds are in disfavor on that road. This traveling engineer is supposed to be an honorable man and truthful. Is it possible that other roads are intrusting good compounds to men like this engineer? If so, no one need wonder that they are changed to simples.

EFFICIENCY OF HIGH SPEED PLANER TOOLS.

High-speed tools are much less efficient on planers and shapers than on lathes, drilling machines and boring mills. Some maintain that this is due to the repeated shock to the tool as it enters the work, while others believe that the repeated heating and cooling of the tool has a tendency to anneal it and destroy its temper. A planer manufacturer, who has devoted considerable time in experimental work and study of this question, has come to the conclusion that, while the repeated heating and cooling may be a factor affecting the efficiency of the tool, that the vibration which takes place when the tool is taking a heavy cut is also a very important factor in reducing its cutting efficiency. With the tool taking a heavy cut any considerable vibration of the planer will result in a violent and repeated straining and bending of the point of the tool. The construction of the planer is such that there is an opportunity for much greater vibration than on a lathe. By designing a planer with the object of reducing vibration to a minimum this manufacturer found that he could not only take heavier cuts on a certain class of work, but could increase the cutting speed almost 60 per cent. over what could be used on the standard machines, and the only apparent difference in the machine which would appear to warrant any increase in the efficiency of the tool steel was its greater strength and stiffness, which reduced the vibration to a minimum.

PROPORTIONS OF LOCOMOTIVE SHOPS.

Those who have studied locomotive shop plants with a view of establishing, from best practice, the proper proportions between the various departments will find it necessary to closely watch present developments in order to keep a proper balance between the various factors involved. A large shop plant, built about three years ago, which had at that time an apparently correct balance between the size of the locomotive shop, the boiler shop and the blacksmith shop, has been rather rudely upset by two simple conditions, which have changed with subsequent progress. When the shops were built the road used very little cast steel, forgings being employed exclusively in the small locomotive parts. By the substitution of steel castings for forgings the blacksmith shop is now twice too large.

The boiler shop, however, is not half large enough, and is to be extended at a great expense while the shop plant is yet almost new. The road has purchased much larger locomotives than ever before, and as these are worked to the limit of their capacity, the boiler work has become exceedingly heavy, and as every new boiler is working under a higher pressure than formerly, each boiler requires more work than that which would result from merely increase in the size. Furthermore, with the high pressures it is impossible to repair fireboxes by patching, and nowadays a whole new sheet is required, whereas a patch would have sufficed in the days of 150 lbs. pressure.

A little reflection on the effect of progress, as shown in this particular case, illustrates the necessity for the most careful planning of a railroad shop, for it is not good business policy to spend perhaps a million dollars in a shop plant and after two or three years find it necessary to double the capacity of some of the departments. While the developments of the future cannot always be foreseen, they may usually be fairly

well provided for. This experience points to the absolute necessity in designing railroad shops of placing the responsibility upon those who are in position to know the tendencies, and of giving these officials the authority to provide adequately for the changes which are sure to come. Not until the railroads are prepared to recognize motive power problems and place them in the hands of officials ranking with the vice-presidents of the roads, centralizing the authority very near the president, can these problems be properly, that is to say, economically administered.

MEETINGS AND TEAM WORK.

Meetings of responsible heads of departments at regular intervals present possibilities which cannot be appreciated by those who have not had experience with them. The formal kind of meeting, with stenographic reports, is not what is meant, and the slightest tendency toward speechmaking spoils the ideal. The mere gathering together of men associated in the same general pursuit for a comparison of notes is the desirable thing.

For several years the mechanical department officials of one of the Western roads, including general foremen, master mechanics, superintendents of the car and locomotive departments and the mechanical engineer have met with the chemist, storekeeper and others at noon in a well-equipped lunch room in one of the shop buildings. At that table a pleasant gathering of friends assembles daily, and in an agreeable after-dinner half hour of shop talk many important matters are discussed. The writer has been impressed with the importance of this influence, because the men around that table have often started movements of great value to the road. These men work in close accord. They have an unusual opportunity to learn what their colleagues are "up against," and they discuss their work and their troubles very much as it was done in the old-fashioned family. Conversations at that table have resulted in improvements which have been widely adopted all over the country. On the same road the department foremen meet at a stated time every Monday morning, for a brief session, to consider the plan for the week's work in the shops. The department heads fully understand each others' difficulties, and a helpful spirit exists all around. If a delay is likely to occur in any department its effect is discounted in advance. The boiler shop may have a spare space for a few days for an extra engine. This or that work may be hurried a little in order to preserve the general shop schedule. This practice "takes up" a great deal of lost motion, and is to be most highly commended.

Commercial concerns have used this method with telling effect, and those of the highest standing have for years made a practice of team work of this kind. The plan possesses even greater possibilities on railroads, where daily work presents an almost continuous emergency.

This sort of comparison of notes should be practised also between departments. Much is heard of the shifting of responsibility from one department to another, as if the road were composed of warring factions, each endeavoring to put the other in a bad light to save itself. This sort of thing prevents businesslike management. A monthly meeting to study the performance sheets would be a powerful influence in extending the team work and breaking down the department defenses, which have been a great and entirely unnecessary expense. There is no official who can help a division superintendent more than can the master mechanic and vice versa, if these men understand each others' problems. Time required to obtain such understanding is well spent. For example, the superintendent could help the master mechanic wonderfully if he understood the roundhouse difficulties, and the master mechanic could help the superintendent if he knew more about the trains and traffic. It seems almost absurd to suggest that the efficiency of a railroad organization would be greatly increased if the departments forgot themselves and thought only of the general result. But such a suggestion is urgently needed.

MOTOR CARS FOR STEAM RAILROADS.

In a report recently made to the superintendent of motive power of the Northern Pacific Railway by Mr. W. J. Bohan, the following discussion of motor cars vs. steam locomotives is included:

Three power schemes for driving motor cars have been developed, steam, gasoline or oil engines with mechanical drive, and gasoline or oil engines coupled to electric generators supplying current to motors on the car axles. On the steam driven cars the vertical type of boiler provided with horizontal cylinder is employed (See AMERICAN ENGINEER, November, 1897, page 367, and April, 1898, page 135), coal, coke or oil being used for fuel. Owing to the limited space available for the boiler it has been difficult to obtain sufficient steam capacity and their operation has been more or less unsuccessful on account of boilers not being able to meet demands when maximum power is required. Some foreign roads are operating this class of equipment, but their economy has not as yet been proven.

The gasoline equipments, a number of which are now being tried, have some advantages, chief of which is the fact that they are self-contained and outside of oiling require little attention. They also have a number of disadvantages, among them, the necessity of using compressed air or other means for starting the engines, and their requiring complicated controlling mechanisms and clutches to connect the engines to axles so as to provide for ample power and smooth starting of car. The question of economical operation of gasoline equipment is also doubtful unless gasoline can be purchased at a low price or coal becomes very high, either of which conditions is not in evidence on this line at the present.

The Rock Island Power Committee, reviewing the subject (AMERICAN ENGINEER, April, 1905, page 121), recommends a steam driven car with a large, properly constructed horizontal boiler, using oil for fuel. Oil is recommended as a fuel on account of its being plentiful and cheap along this particular line. What saving can be effected with such a car over a steam locomotive equipped for oil burning is not given.

The Chicago, Burlington & Quincy Railway has recently built a 225-h.p. gasoline electric motor car designed to haul a trailer for carrying passengers, the motor car itself being used for the power equipment, mail and baggage. A test of this car was made recently, but as yet we have no figures on the actual cost of operation.

Equal capacity considered, the apparent saving in fuel to be effected on any of the motor cars is slight, the main saving being clearly one of labor which may be accomplished by doing away with one or more of the train crew. The following are two tables taken from the report of the Rock Island Power Committee showing comparative cost of motor cars and locomotive with train.

Table 1.—Showing saving in operation of a steam driven motor car with a seating capacity of 52 (as used by the Taff Vale Railway Company) over locomotive and four carriages:

	Motor coach cost per train mile. d.	Engine and four carriages cost per train mile. d.
Running.		
Engine coal	1.36	3.03
Water	.12	.36
Oil and other stores	.19	.46
Cleaning	.07	.33
Steam raising, etc	.09	.10
Washing out	.08	.08
Carriage cleaning	.10	.55
Carriage lighting	.12	.32
Oil	.01	.05
Repairs, Renewals.		
Engines	.95	3.48
Carriages	.51	2.75
Wages.		
Enginemen	1.37	1.96
Trafficmen	.56	1.45
	5.48 (10.96c.)	14.92 (29.84c.)

Table 2.—Saving in operation of motor car over two-car train with locomotive:

Approximate cost—		
Passenger cars		$5,000
Baggage, mail and express cars		5,000
Engine and tender		7,000
		$17,000
Motor car		12,000
Difference		6,000
Weight of train—		
Passenger car		35 tons.
Baggage car		30 tons.
Engine and tender		65 tons.
		130 tons.
Weight of motor car		65 tons.
Difference		65 tons.
Cost per day for wages—	Train.	Motor car.
Engineer	$3.50	$3.50
Fireman	2.25	2.25
Conductor	3.50	3.50
Brakeman	2.00	——
Baggageman	2.50	$9.25
	$13.75	
Add for R. H. care	3.00	
	$16.75	
Add interest on $5,000 at 6 per cent	1.00	
	$17.75	
Cost of operation of train per day		$17.75
Cost of operation of motor car per day		9.25
		$8.50
Saving in fuel per day		5.00
Total saving per day in operation of motor car		$13.50
Capitalized at 5 per cent.	$13.50 × 360 =	$97,200
	0.05	

In both of the above tables the comparison is unfair in that the cost of operating one car is compared with the cost of operating an engine and a two or four-car train having greater weight and carrying capacity. In Table 2 the fixed charge should be reversed. The average motor car costs $12,000. The majority of railroads in this country have numbers of locomotives, such as would be required in this service, which they would be glad to dispose of at $2,500 each. The same is true of this class of cars which can only be used for branch or suburban service and the value of which would not exceed $3,000 each. For a comparison of the cost of operating a locomotive and one combination baggage and coach and a gasoline electric motor car of equal passenger and baggage capacity the following seems to be fairer.

Table 3.—Comparative statement showing cost of operating a locomotive and one combination coach and baggage car and a motor car of equal capacity.

A 15 x 22-in. locomotive complete with coal and water weighs 60 tons. A combination passenger and baggage car of equal freight and passenger capacity to a 65-ft. motor car weighs 22 tons. The total weight of the above, for which a motor car would be substituted is 82 tons, with a horse power of about 500 and a speed limit of 60 m.p.h.

Value of the above locomotive is	$2,500
Value of the above car is	3,000
Total	$5,500
Cost of operation per day will be—	
Crew, 1 Engineer	$4.00
1 Fireman	2.35
1 Conductor	3.50
1 Brakeman	2.25
Assuming a 50-mile run doubled each day of 100 miles per day, the locomotive and one car would make 50 miles per ton of coal based on an average speed of 20 miles an hour. The fuel consumption for the above run would be 3 tons per day at $2 per ton	6.00
(One ton of coal allowed for building fires, keeping up steam when not running, etc.).	
Repairs for the locomotive 100 miles at 2½ cents per mile	2.50
Repairs on car, per 100 miles	.50
Roundhouse expense	1.75
Oil, waste and other supplies	.50
Water	.25
	$23.60
Interest on investment at 5 per cent	.76
Total	$24.36

A 200-h.p. combination gasoline electric motor car, length 65 ft., weight 65 tons, baggage and passenger capacity equivalent to the above combination car would cost $12,000.

Based on 40 watt hours power required per ton mile at an average speed of 20 miles per hour, as determined by recent tests. Gasoline estimated at 13 cents per gal., one gal. producing 6½ h.p.h., the cost of operation per day will be:

Crew—1 Engineer	$4.00
1 Conductor	3.50
1 Brakeman	2.25
Gasoline per day (100 miles), at 7c. per train mile	7.00
Gasoline lost by evaporation, waste, etc., 15 per cent	1.05
Repairs based on 100 miles per day, at 3c. per mile	3.00
Terminal expenses	1.00
Oil, waste and other supplies	.50
	$22.25
Interest on investment at 5 per cent	1.53
Total	$23.78

The above comparison shows a saving of 58 cents per day in favor of the motor car. You will note that in the table showing cost of operating the motor car that the wages of fireman is not included. It is a question, however, whether this man can be dispensed with on account of coming in contact with State laws requiring two men in cab, cases of which have been known. The motor car equipment is handicapped in that its hauling capacity and range of speed is limited. The locomotive on the other hand has wider range of speed and in cases of necessity, such as excursions, etc., which are always forthcoming on branch lines, will haul several cars handily. The locomotive can also be used for switching at terminals, which is often desirable.

Summing up the whole situation there seems to be very little in the motor car proposition at present or until their success has been better demonstrated. In case a motor service is desirable on some branch line, why not make the jump from steam to electricity at once and install wiring on branches where current can be bought for around 1 cent per k.w.h. and operate a few street cars, the cost and success of operating which is a certainty.

THE QUESTION OF COST.—The *dollar* is the final term in almost every equation which arises in the practice of engineering in any or all of its branches, except qualifiedly as to military and naval engineering, where in some cases cost may be ignored. In other words, the true function of the engineer is, or should be, not only to determine how physical problems may be solved, but also how they may be solved most economically. For example, a railroad may have to be carried over a gorge or valley. Obviously it does not need an engineer to point out that this may be done by filling the chasm with earth, but only a bridge engineer is competent to determine whether it is cheaper to do this or to bridge it, and to design the bridge which will safely and most cheaply serve, the cost of which should be compared with that of an earth fill. Therefore, the engineer is by the nature of his vocation, an economist. His function is not only to design, but also so to design as to insure the best economical result. He who designs an unsafe structure or an inoperative machine is a bad engineer; he who designs them so that they are safe and operative, but needlessly expensive, is a poor engineer, and, it may be remarked, usually earns poor pay; he who designs good work, which can be executed at fair cost, is a sound and usually a successful engineer; he who does the best work at lowest cost sooner or later stands at the top of his profession, and usually has the reward which this implies.—*Henry R. Towne, before Purdue students.*

GETTING THE MOST OUT OF A LATHE.

With a belt-driven lathe having a four or five-step cone pulley and back gears, the speed steps are so large that the ordinary operator, if he understands his work, can usually determine which speed is most suitable for the work he has in hand. With a variable speed motor driven lathe a greater number of speeds are furnished, and where these speeds increase by from 10 or 15 to 20 per cent. increments the problem of selecting the most suitable speed for a particular piece of work is more complicated. In some of the very large manufacturing establishments it has been found advisable to have a "speed foreman," whose duty it is to advise the machine hands as to the speed to be used on different classes of work, and in addition he is expected to improve the machine tools and the methods of handling the work, with a view to increasing the output. Such a man must, of course, be thoroughly familiar with the practical part of the work and ordinarily uses one of the special slide rules to assist him in determining the cutting speeds which it is advisable to use on different classes and sizes of work. A man of this kind would undoubtedly be a paying proposition in a very large shop, but would probably be out of the question for the smaller shops.

The problem then is to provide some simple means to enable the ordinary machine hand to easily select the best speed, within reasonable limits, for a given piece of work. It is first necessary to decide on the kind of tool steel which will be used, and then by means of a careful set of experiments and by practical observation to determine the best rates of cutting speed with various materials and under different conditions. As the rate of cutting speed depends on the kind of tool steel, the material to be cut, the nature of the work and the finish required, it is, of course, necessary for each shop to determine for itself the most suitable rates of cutting speed for its conditions. The machine tool operator should then be furnished with data as to the cutting speed in feet per minute to be used with various materials.

It is then necessary to furnish him with some simple (to be effective it must be quite simple) means of determining the proper position of the belt and arrangement of back gears on a belt-driven lathe, or of the controller handle and gearing on a motor-driven lathe to obtain the desired rate of cutting speed on the diameter of work he is to turn.

furnished by the controller there are four runs of gearing, so that a very large number of speeds are available. The letters with each controller point number designate the run of gearing which is to be used; F, means the fastest run; M.F., medium fast; M.S., medium slow and S. slow. This same scheme can easily be adapted for use with boring mills and drilling machines.

This table was made up by the machine shop foreman from

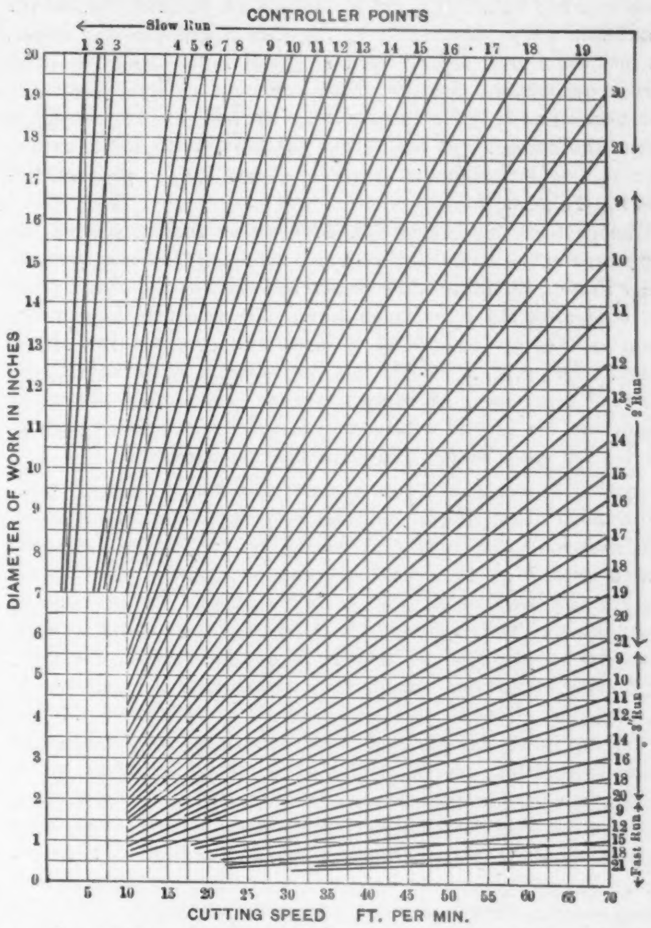


FIG. 2—DIAGRAM SHOWING MOTOR CONTROLLER POINT FOR ANY CUTTING SPEED ON VARIOUS DIAMETERS OF WORK.

CONTROLLER POINTS AND RUN OF GEARING TO BE USED TO OBTAIN VARIOUS RATES OF CUTTING SPEED ON DIFFERENT DIAMETERS OF WORK.

Diameter of Work.	Cutting Speed—Feet Per Minute.								
	30	35	40	45	50	55	60	65	70
1 in.	M.F.—18	M.F.—20	F.— 9	F.—10	F.—12	F.—13	F.—14	F.—15	F.—16
2 ins.	M.F.—11	M.F.—13	M.F.—14	M.F.—16	M.F.—17	M.F.—18	M.F.—19	M F.—20	M.F.—21
3 ins.	M.S.—19	M.S.—21	M.F.— 9	M.F.—11	M.F.—12	M.F.—13	M.F.—14	M.F.—15	M.F.—16
4 ins.	M.S.—16	M.S.—18	M.S.—19	M.S.—20	M.F.— 8	M.F.—10	M.F.—11	M.F.—12	M.F.—13
5 ins.	M.S.—13	M.S.—15	M.S.—16	M.S.—18	M S.—19	M.S.—20	M.F.— 8	M.F.— 9	M.F.—10
6 ins.	M.S.—10	M.S.—12	M.S.—14	M.S.—16	M.S.—17	M.S.—18	M.S.—19	M.S.—20	M.S.—21
7 ins.	M.S.— 9	M.S.—11	M.S.—12	M.S.—14	M.S.—15	M.S.—16	M.S.—17	M.S.—18	M.S.—19
8 ins.	S.—40	M.S.— 9	M.S.—11	M.S.—12	M.S.—14	M.S.—15	M.S.—16	M.S.—17	M.S.—18
9 ins.	S.—19	S.—21	M.S.— 9	M S.—11	M.S.—12	M.S.—13	M.S.—14	M.S.—15	M.S.—16
10 ins.	S.—18	S.—19	S.—21	M.S.— 9	M.S.—11	M.S.—12	M.S.—13	M.S —14	M.S.—15
11 ins.	S.—17	S.—18	S.—20	M S.— 8	M.S.— 9	M.S.—11	M.S.—12	M.S.—13	M.S.—14
12 ins.	S.—16	S.—17	S.—19	S.—20	M.S.— 8	M.S.—10	M.S.—11	M.S.—12	M.S.—13
13 ins.	S.—14	S.—16	S.—18	S.—19	S.—21	M.S.— 9	M.S.—10	M.S.—11	M.S.—12
14 ins.	S.—14	S.—16	S.—17	S.—18	S.—20	S.—21	M.S.— 9	M.S.—10	M.S.—11
15 ins.	S.—13	S.—15	S.—16	S.—18	S.—19	S.—20	M.S.— 8	M.S.— 9	M.S.—10
16 ins.	S.—12	S.—14	S.—16	S.—17	S.—18	S.—19	S.—20	S.—21	M.S.— 9

NOTE.—The motor has a 21 point controller, and drives the lathe through four different runs of gearing. F. indicates that the fast run of gearing is to be used; M.F., medium fast; M.S., medium slow, and S., slow.

FIG. 1.

The best method of doing this which has come to our notice is one used at the McKees Rocks shops of the Pittsburgh & Lake Erie Railroad. On the headstock of each lathe is fastened a brass plate with a table on it somewhat similiar to that shown in Fig. 1. The table shown is copied from one on a Putnam 20-in. lathe, and the operator can easily tell at a glance the controller position and run of gearing to use for any rate of cutting speed from 30 to 70 ft. per minute on diameters from 1 to 16 ins. This lathe is driven by a Crocker-Wheeler 7½ h.-p. motor with a 21-point controller operating on the multiple voltage system. In addition to the speeds

the chart shown in Fig. 2, which was furnished to him from the mechanical engineer's office. This chart shows what position of controller and run of gearing to use to obtain any cutting speed from 10 to 70 ft. per minute on any diameter up to 20 ins., but the machine operator would probably experience trouble in reading it, and the table which is much simpler and is sufficient for all practical purposes was made from it. The chart was very easily plotted with the aid of the diagram on Fig. 1, page 165, of our May, 1903, issue, which shows the relation between the speed and power of a Crocker-Wheeler motor using the 21 point field weakening controller.

SUPERHEATERS IN LOCOMOTIVES.

BELGIAN STATE RAILWAYS.*

The Belgian State Railway has recently put in service a series of simple expansion locomotives, the boilers of which carry a pressure of 14 atm. (205.8 lbs. per sq. in.), with an inside diameter of 1.600 m. (5 ft. 3 ins.) while that of the cylinders is 520 mm. (20½ ins.). This class of engine gives the maximum power obtainable by the simple expansion of steam. In fact every new enlargement of the cylinders would demand larger dimensions for the crank-axle and moving parts; on the other hand, the necessity for clearing the loading-gauge limits the diameter of the boiler; in short, with simple expansion it would be difficult to utilize steam with a pressure exceeding 14 atm.

Under these conditions and in view of further increasing the power of the engines, it becomes necessary to resort to some other system for increasing the useful work of the steam without enlarging the existing boilers. The two solutions under consideration are compound working and superheating of the steam. The first of these does not strictly come within the limits of this paper. Arrangements for producing superheated steam and the results obtained with a system that has been in service for more than a year will now be considered.

SCHMIDT SUPERHEATER FOR SIMPLE EXPANSION LOCOMOTIVES.

For some time the locomotive department had their attention drawn to the favorable results obtained by using superheated steam in industrial stationary engines. By superheating the theoretical cycle is improved, and the pressure is maintained. The volume of steam is augmented proportionately to the rise of temperature, diminishing, however, its density. In other words, when the degree of superheat is sufficient to prevent the loss due to condensation in the cylinders, then the surplus heat contained in superheated steam is sufficient to reheat the walls of the cylinders, maintaining the temperature necessary to get rid of the condensation and the loss of work during expansion. These trials have brought to light a valuable property of superheated steam. It was recognized as a bad conductor of heat, contrary to that which obtains when steam is in the saturated state.

These numerous advantages, tested by many trials undertaken by most competent engineers, are specially valuable to the locomotive engine. The employment of a practical superheater augments the power of the boiler, and the utilization of superheated steam is most economical. This is well observed in hauling heavy goods trains on sections of the line having heavy gradients. For it is then indispensable to reduce to the minimum the consumption of water and steam. For the suburban trains having frequent stoppages superheat is again highly recommended, because it reduces the condensation necessitated by the frequent stops. High speed is also favorable to the employment of higher superheated steam, the great fluidity of which, as well as its dryness, permit running with early cut-offs, which helps the boiler just at the time when it is most hard pressed.

On the other hand, the passage of saturated steam through the pipes (and steam ports) is more difficult, and entails inevitably an increase of condensation. Having in mind these various theoretical and practical considerations the administration of the Belgian State recognized the great utility of pushing on their investigations in this direction.

It was in 1900 that the administration of the State Railways opened negotiations with M. Schmidt, the German expert, who at that period had already introduced some locomotives with steam superheaters formed principally of a series of rings placed in the smoke-box.

This last plan, described in most of the technical newspapers, and applied to a Prussian State locomotive shown in Paris in 1900, adapted itself without difficulties to outside cylinder engines.

*A paper by J. B. Flamme, general inspector Belgian State Railways, read before the Institution of Mechanical Engineers.

It is not quite the same for inside cylinder engines which, as in England, are generally used in Belgium. In this case it becomes impossible to clear from the bottom of the smoke-box the cinders brought by the large flame-tube placed at the base of the barrel.

On the other hand, a superheater, established in the barrel of the boiler and described later (Fig. 4), offers some real advantages. It is lighter, less cumbersome, easy to clean and maintain, and its introduction does not necessitate any important modifications in the smoke-box. Consequently it was this kind of apparatus that the Locomotive Department adopted in a new type of powerful locomotive then being built in the Cockerill Works at Seraing.

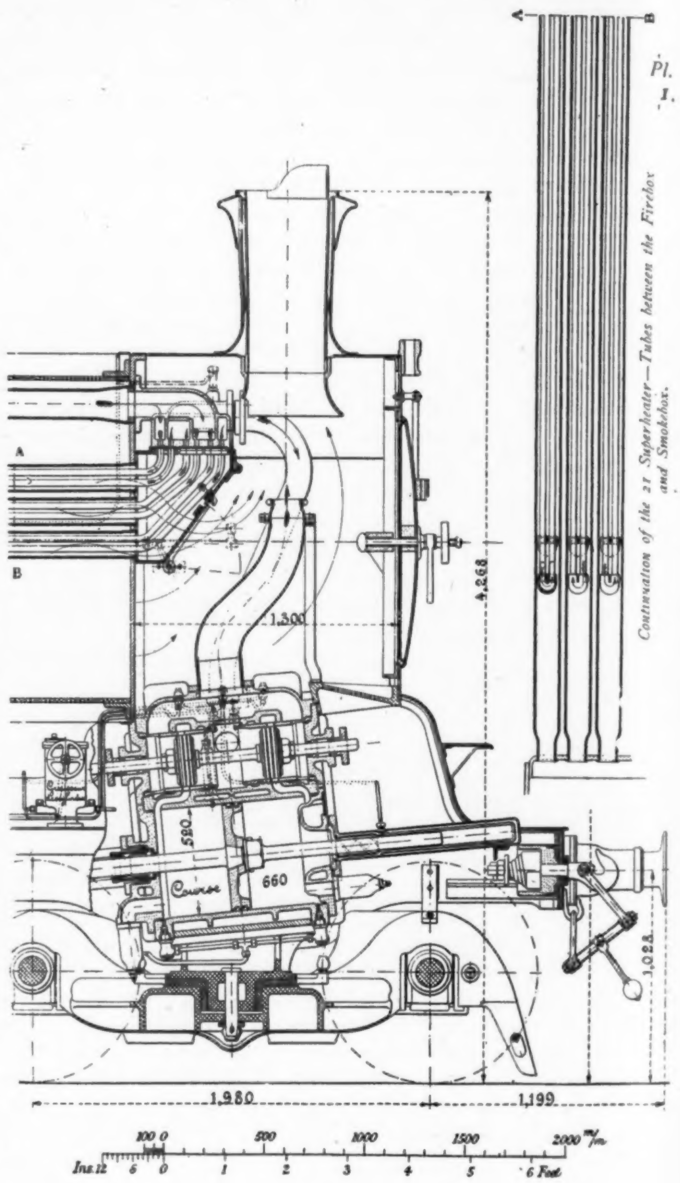


FIG. 1.

At the same time another important question presented itself. Was it absolutely necessary to superheat the steam to a temperature reaching 300 deg. to 350 deg. C. (572 deg. to 662 deg. F.)? It is evident that the more the steam is superheated the more necessary it becomes to give attention to the oiling of the piston-valves and cylinders and to the construction of the stuffing-box. With a view to getting a clear idea of the actual amount of superheat some trials were made with a superheater of small surface installed in the barrel of one of the locomotives, type 35, which will be described later. After several months of experiments it has been recognized that the utilization of steam slightly superheated does not offer any appreciable economy of fuel or increase of power.

On the other hand, with the Schmidt apparatus placed on a

locomotive, type 35, and provided with steam with a temperature varying between 300 deg. and 350 deg. C. (572 deg. to 662 deg. F.), some favorable results have been obtained.

The locomotives compared, one using saturated steam and the other superheated steam, are both of type 35, with six coupled wheels of 1.600 m. (5 ft. 3 in.) with bogie in front. The boiler has a round-topped fire-box, the roof of the furnace being connected to the arch by vertical stays. The fire-box, of a medium depth, burns coal with briquettes varying in quantity with the weight of the trains. The inside cylinders are made with piston slide-valves placed above, steam being admitted in the middle of the valve. This arrangement, with the Stephenson valve-gear, involves the employment of a rocking-shaft, which reverses the position of the valves compared with those having the exhaust port in the middle of the piston-valves.

The six coupled wheels and the bogie are fitted with compressed-air brakes. The engine is illustrated in Figs. 1 to 3.

The principal dimensions are given in the following Table:

The engine provided with the Schmidt superheater has less heating surface than the above, owing to the substitution of 21 tubes of 118 mm. (4⅝ ins.) diameter for 103 tubes of 50 mm. (1 15-16 ins.). For this locomotive the internal heating surface in the tubes is 98.10 m.² (1,056 sq. ft.) and the total heating surface is 130.056 m.² (1,400 sq. ft.).

The exterior superheating surface is equal to 27.15.

The superheater proper is illustrated in Plates 1 to 3, and consists essentially of two parts.

(1) A series of iron tubes of 118 mm. (4⅝ ins.) external diameter, occupying the upper part of the nest of tubes and offering like them a passage for flame and hot gases.

(2) Some U shaped tubes grouped in pairs among the flame tubes and used for the circulation of the superheated steam.

A steam collector in several divisions is placed on the top of the smokebox. Some supplementary parts complete the system.

There must also be a diaphragm to close the flame tubes

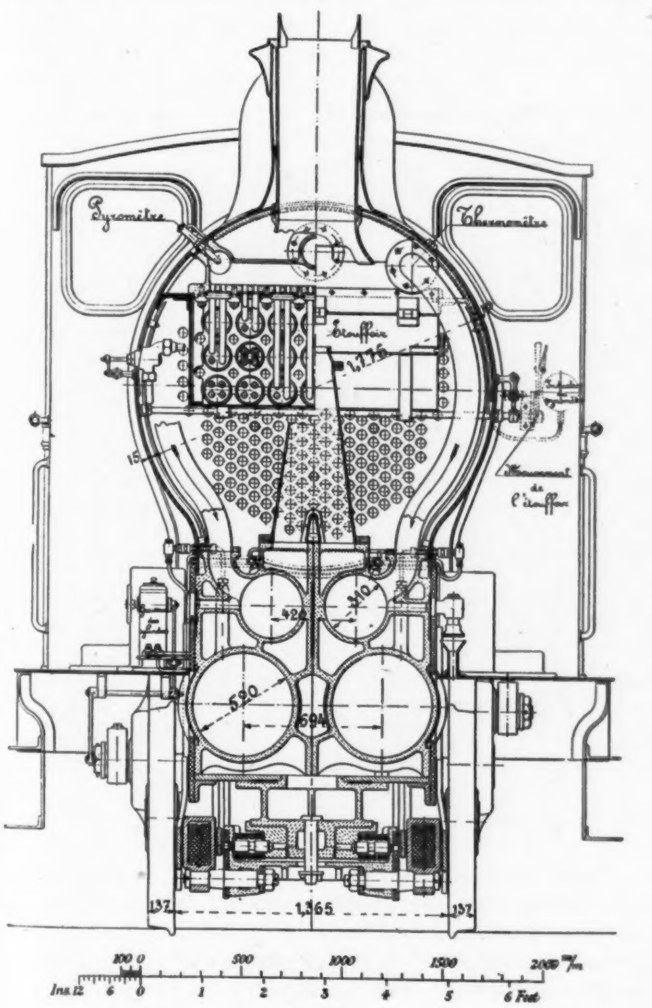


FIG. 2.

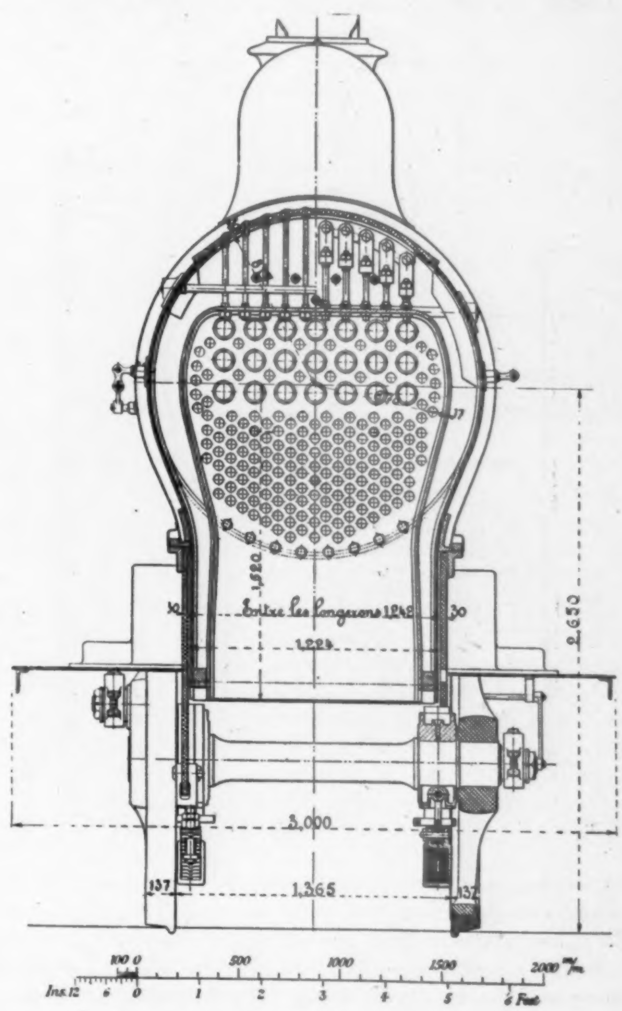


FIG. 3.

Cylinders:—	
Diameter	520 mm. (20½ ins.)
Stroke	660 mm. (26 ins.)
Working pressure	14 atm. (205.8 lbs. per sq. in.)
Diameter of driving wheels	1.600 m. (5 ft. 3 ins.)
Height of center of boiler above rail	2.650 m. (8 ft. 8 5-16 ins.)
Tubes:—	
Length	4.130 m. (13 ft. 6½ ins.)
Exterior diameter	50 mm. (1 15-16 ins.)
Number	271
Heating surface:—	
Tubes, internal	158.25 m². (1,703 sq. ft.)
Firebox	14.90 m². (160 sq. ft.)
Total	173.15 m². (1,863 sq. ft.)
Grate surface	2.84 m². (30½ sq. ft.)
Weight in running order:—	
First axle	9740 K. (9.5 tons.)
Second axle	9740 K. (9.5 tons.)
Third axle	18215 K. (17.9 tons.)
Fourth axle	17850 K. (17.5 tons.)
Fifth axle	17500 K. (17.5 tons.)
Total weight	72965 K. (71.8 tons.)
Adhesion weight	53565 K. (52.7 tons.)
Tractive effort $\frac{p\ d^2\ l}{D}$ =	16128 K. (15.8 tons.)

when steam does not circulate in the superheating tubes. This diaphragm is handled by the aid of a lever near the engine driver.

A mercury thermometer shows the temperature of the superheated steam at the entrance of the steam-pipe. The degree of superheat is read on a graduated quadrant placed in the cab.

The large flame tubes, which are of solid drawn iron, are screwed into the firebox tube plate and expanded in the smokebox tube plate.

The superheating tubes, also of solid drawn iron, are protected against the action of the flame at the fire end by cast steel caps.

In the smokebox these tubes are expanded into flanged bushes fixed by bolts. The tightness is assured by means of asbestos joints.

Copper, bronze and brass are usually excluded from all parts that come in contact with the superheated steam. For this reason the steam pipes are of iron, and the joints between these pipes and the cylinders are formed with cast iron flanges.

The metallic packings of the piston rods and valve spindles are composed of cast rings and white metal, the contact of which on the rod is obtained by a spring permitting small side movements of the rod.

The slide valves are cylindrical with steam admission in the middle of the valve, which reduces the packing to simple bronze rings with lubricating grooves. The slack between each valve and the cylindrical chamber against which it rubs is closed by means of three cast iron rings of suitable section, the steam pressing on the interior of the principal segment. The oiling of the cylinders and valves is done by a lubricator in six sections. The lubricant used is a mineral oil with a high flash point.

The trials of these two locomotives took place with goods trains of accelerated speed and local passenger trains running on the Luxemburg line, the extremely undulating profile of which contains many inclines of 16 per 1,000.

Each locomotive worked twenty-four goods trains weighing 250 tons (246 tons) and twelve passenger trains weighing an average of 150 tons (147.6 tons). The total journey made by each engine amounted to 11,500 kilometers (7,146 miles). The saving of coal per train-kilometer in favor of the superheated steam engine was found to be 13.33 per cent., and the water consumption was reduced 18 per cent.. On the other hand, the expenses of lubricating increased in a fixed proportion.

After four months of trials on the Luxemburg line, more precise experiments were organized with the through passenger trains on the Brussels and Charleroi line, which has a series of inclines of 13 per 1,000. For ten days, during which the climatic conditions remained invariable, these two locomotives hauled alternately the same train of 250 tons (246 tons). The saving in favor of the superheated steam locomotive amounted to 12.5 per cent for fuel and 16.5 per cent. for water. Moreover the speed raised at the top of the incline showed an average increase of 9.5 per cent., all the conditions being exactly the same.

As regards maintenance the superheated steam locomotive, type 35, has not required special attention during its 1½ year's service.

These early favorable results have led to the Belgian State Railway venturing on the application of superheat to locomotives, on a larger scale. With this in view twenty-five locomotives, comprising five different types, all provided with the Schmidt superheater described above, are actually in course of construction or are about to be put to work.

Amongst these last are a certain number of locomotives of type 35, which have fully confirmed the favorable results obtained by the first engine of this kind.

Among the number of services actually and successfully run by these engines is to be particularly noted the hauling, from Brussels to frontier, of express trains going to Paris. These trains, whose tare weight of vehicles exceeds 340 tonnes (334⅝ tons), surmount the 17 kilometers (10.56 miles) separating Mons and the frontier in 17 minutes, against a continuous up grade with inclines varying from 1 in 125 to 1 in 55.

Experimental Superheater on a Compound Locomotive.

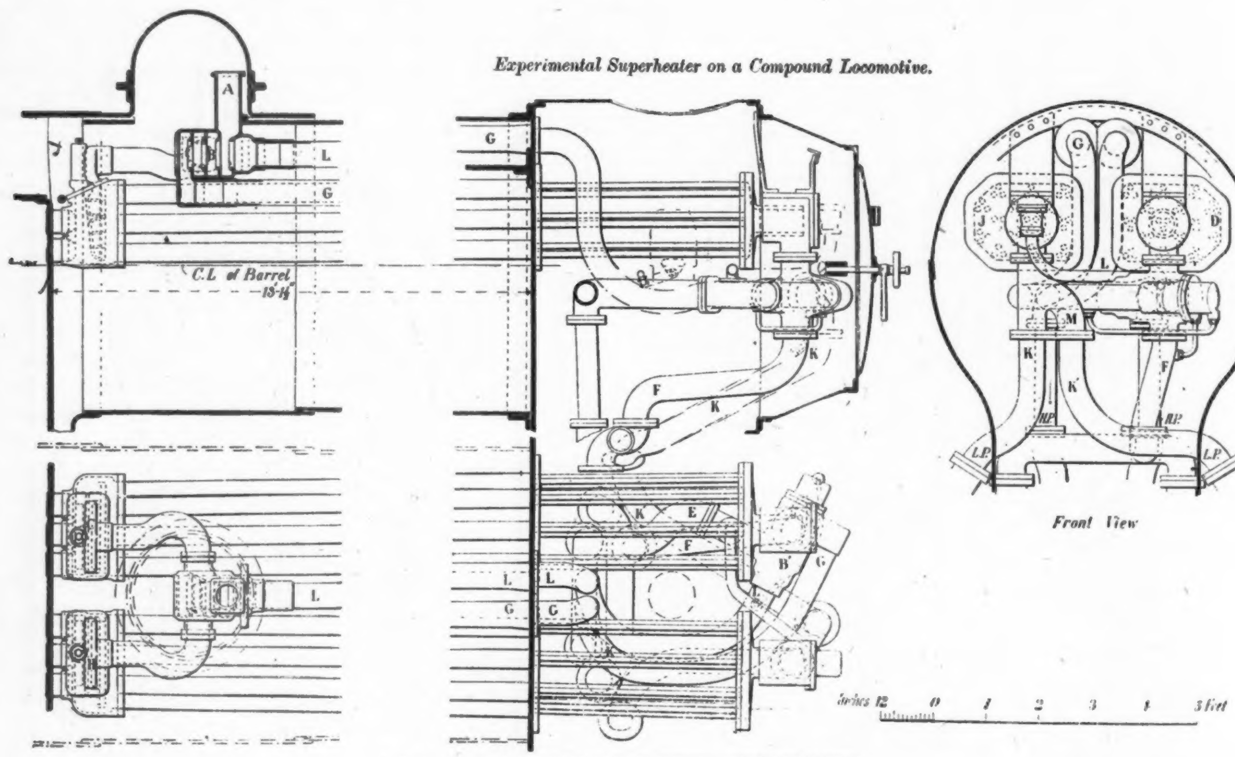


FIG. 4—COCKERILL LOCOMOTIVE SUPERHEATER.

Cockerill Superheater for Compound Locomotives.

It is seen from the preceding that it is now known that superheated steam as applied to locomotives is susceptible of giving remarkable results which come within the domain of practice. The State Railway has decided to persevere with their experiments in combining superheat with compounding, because they perceive that there is a most interesting question to elucidate.

Is it more economical to divide the superheater into two parts in such manner as to raise the temperature at the entrance to both the H.P. and the L.P. cylinders, or, on the other hand, to devote the whole power of the apparatus to superheating the steam before it enters the L.P. cylinders? The Cockerill Company, after numerous investigations, have just completed a superheater that will enable them to settle this question.

This entirely new system is being continually tested on a series of compound engines, with four cylinders, and six-coupled wheels of 1.80 m. diameter (5 ft. 10 ins. diameter) with a bogie. This locomotive, called 19*bis*, possesses a boiler having an interior diameter of 1.65 m. (5 ft. 5 ins.) diameter, and is pressed to 15.5 atm. (227 lbs. per sq. in.).

The H.P. cylinders are inside and connected to the leading coupled axle; the L.P. cylinders are outside and drive the second axle. The four cylinders are placed on the transverse axis of the bogie. The two valve motions of the Walschaert type are outside. They present several peculiarities due to the employment of cylindrical valves, with the steam introduced in the middle. The leading dimensions of the engine, type 19*bis*, are shown in the Table below:

Diameter H.P. cylinders	= 0.36	14 3-16 ins.
Diameter L.P. cylinders	= 0.62	= 24 13-32 ins.
Stroke	= 0 68	= 26 25-32 ins.
Initial pressure	= 15.5 atm.	= 227 lbs. per sq. in.
Diameter of driving wheels	= 1.80 m.	= 5 ft. 11 ins.
Height, rail to center of boiler	= 2.80 m.	= 9 ft. 2⅝ ins.
Tubes:—		
Length of	= 4 0 m.	= 13 ft. 1½ in.
Number and outside diameter.	= 30 of 107 mm.	= 4 7-32 ins.
	= 219 of 50 mm	= 1 31-32 ins.
Heating surface:—		
Interior of tubes	= 157.62 m^2.	= 1,696 6 sq. ft.
Of firebox	= 18.35 m^2.	= 197.5 sq. ft.
	175.97 m^2.	= 1,894.1 sq. ft.
Area of grate	3.01 m^2.	= 32 3 sq. ft.

The apparatus for superheating the steam may be used in two ways. One may heat the steam near to the entrance to the H.P. cylinder, and afterwards near to those of the L.P. cylinders, or at the entrance of the L.P. only. The superheater shown in Fig. 4 indicates the general arrangement, comprising two series of large flame tubes containing the circulating pipes intended to superheat the steam.

The role of the compartments C and H, placed inside the barrel, and of the collectors J and D, installed in the smokebox, will be dealt with later on in connection with the explanation of the working of the apparatus.

In B there is a valve with three pistons to divert the steam coming from the regulator towards the compartment C, or into the tube L, according as it is required to operate the superheat to H.P. and L.P. or to L.P. only. The movements of the valve B are automatically repeated, thanks to the presence in the tube L of an identically similar valve located within B^1. The destinations of the different pipes is made clear by following the course of the steam as explained below.

FIRST CASE.—Superheat at the entrance of H.P. and L.P. The steam on leaving the regulator A makes its way, after passing B, towards the compartment C; from there it traverses the left set of superheater tubes and enters the collector D, whence it goes to the H.P. cylinders by passing through the valve B^1 and pipes E. The superheated steam, after doing work in the H.P. cylinders, goes out by the exhaust pipe, traverses the valve B^1, after the pipe G, lodged in the interior of the barrel to enable it to enter the compartment H. From there the steam goes into the superheating tubes (the right set), and arrives by the pipe K leading toward the L.P. cylinders.

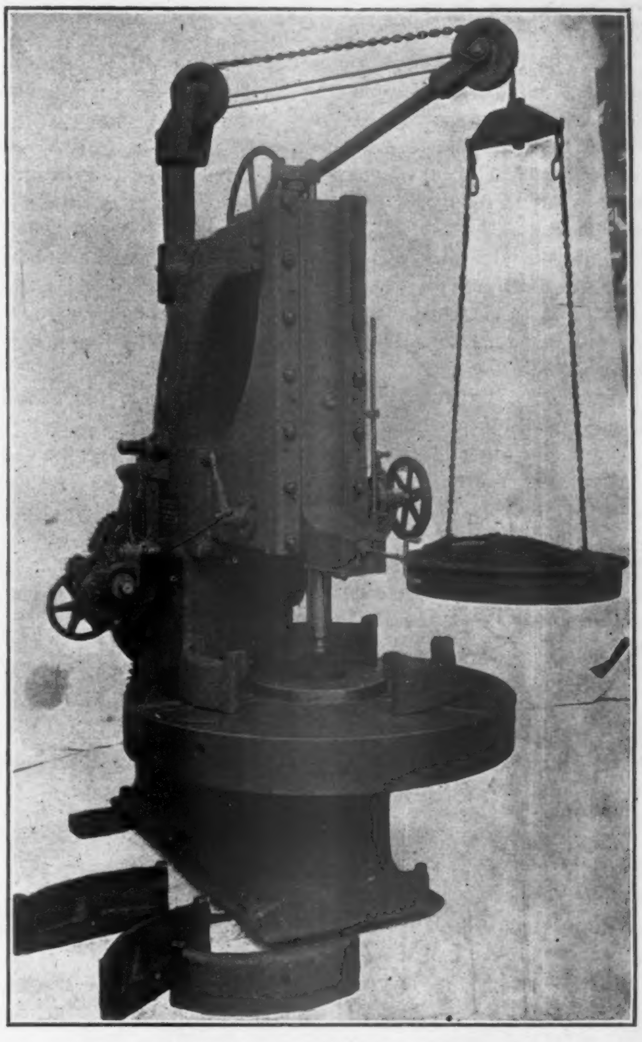
SECOND CASE.—Superheat at the entrance of the L.P. cylinder. The valve B is placed by the driver in a position that diverts the direction of the steam, directly from the regulator into the pipe L; from there it goes to the H.P. cylinders after having passed through the valve B^1 and the delivery pipes E. On leaving the H.P. cylinders the steam traverses the pipes F, the valve B^1, and enters into the collector D. From the front it passes back through the left set of superheater tubes and arrives at the compartment C. From this it passes through the valve B into the compartment H, and traverses through the right group of superheater tubes, whence it goes into the collector J, and from there by the delivery pipes K into the L.P.

A locomotive of type 19*bis*, showing this pattern of superheater, is exhibited in the Liége Exhibition. Trials are going to be continued with a second identically similar engine, to determine which is the more advantageous mode of working to adopt for the new superheater.

It is manifest that if the superheat is required at the entrance of the L.P. cylinders only, it will be possible to dispense with a certain number of parts of the superheater and by that means remedy the obstruction in the smokebox.

CAR WHEEL BORING MACHINE.

The Sellers car wheel boring machine, shown in the accompanying illustration, has several important features which enable it to handle the wheels from the floor to the table, bore and replace them on the floor at a rapid rate with a minimum amount of labor and responsibility on the part of the operator. The universal chuck is so designed that the act of starting the machine causes it to close upon the wheel and hold it securely in place. The stopping of the table automatically opens the chuck jaws and releases the wheel. By the movement of a hand lever the table may be instantly stopped without shock, thus saving the time ordinarily lost



SELLERS' CAR WHEEL BORING MACHINE.

while it is slowing down. The crane mechanism is such that when the wheel is raised to the proper height for swinging it on the table the hoist automatically stops, and when the operator has swung the wheel into position it gently drops into place.

The boring bar is very stiff and has double cutters, having four cutting edges, thus insuring quick and accurate work. The locking device is such that the cutters may be changed without loss of time. A convenient slide rest is provided for facing the hubs. The table is 50 ins. in diameter and the chuck takes 42-in. wheels. The feeds range from .04 to .87 in. This machine is made by William Sellers & Co., Inc., Philadelphia, Pa.

A HINT.—I think if I were an apprentice in a great company's works I should hunt up some place where work had congested, and I would ask for a chance at the job. I would master it in such a way that I would forthwith be intrusted with a continuance of duties that would tax my resources and insure my growth. A mark is put upon such a man.—*F. H. Taylor, before the Electric Club.*

METHOD OF INSTALLING FLEXIBLE STAYBOLTS.

By B. E. D. Stafford.

It is of the most vital importance to the success of the flexible water space stay that good work be always done in the installation of the complete bolt. There is no excuse for leakage when proper attention is given to methods of installation of a flexible stay, and in tapping the taper holes, which are made in the outer sheet to receive the sleeves, such should be carefully inspected and all plugs and sleeves screwed up to a steam tight fit, and all plugs and all caps which make their seat on the end of sleeve should be screwed up tightly, using graphite in the threads, for by the unscrewing of the caps we are allowed to inspect the staybolt proper, when thought advisable.

Fig. 1 is the method of removing the old bolt by using an enlarged twist drill, following the prick punched center of old bolt, drilling through outer sheet and using a reduced diameter of drill through inner sheet, collapsing the end (C), or separating such by a Wagstaff drill, leaving the hole in outer sheet enlarged ready for roughing reamer for the flexible staybolt sleeve.

Fig. 5 is a butt mill, which enlarges the hole in like manner, from tap drill size.

Fig. 2 is a roughing reamer (B), with guide bar (A), to be used in air drill to quickly straighten and size the hole in outer sheet.

Fig. 3 is a finishing reamer, with guide bar, for exactly sizing each hole previous to tapping.

Fig. 4 is a taper tap with guide bar, ¾ in. taper to the foot, 12-V threads, for finish tapping the hole in outer sheet to receive the sleeve. Taper tapping differs from straight tapping. The reamed hole should always be of exact size for the tap to give good full threads. The tap should not be used to enlarge the hole, for this process is both unmechanical and detrimental to the tap. A straight tap of the right diameter used before the taper tap, facilitates the tapping operation and relieves the taper tap from great strain and clogging.

Fig. 6 shows the method of tapping the inner sheet with the regular staybolt tap to aline with the installed sleeve. A cap (B) of the style (D) flexible stays is used as a means for holding the bushing (C), which holds the shank of the tap in line.

The sleeve is screwed into the outer sheet by the stud nut shown in Fig. 8, and as it takes nearly two turns to make a steam tight fit, after the sleeve just fills the tap hole, it is necessary that the tapping operation should be guaged accordingly.

Fig. 7 shows the style (D) both installed ready for riveting over the end (F). B is a cap such as is used for the flexible stay, cut away for the admission of a dolly bar, bucking tool or holder-on. This cap protects the sleeve face where the cap makes a steam tight joint during the riveting operation. The dolly bar or holder-on is made of a piece of axle, 4 or 5 ins. in diameter. C is a tool steel plug inserted therein, hardened and tempered.

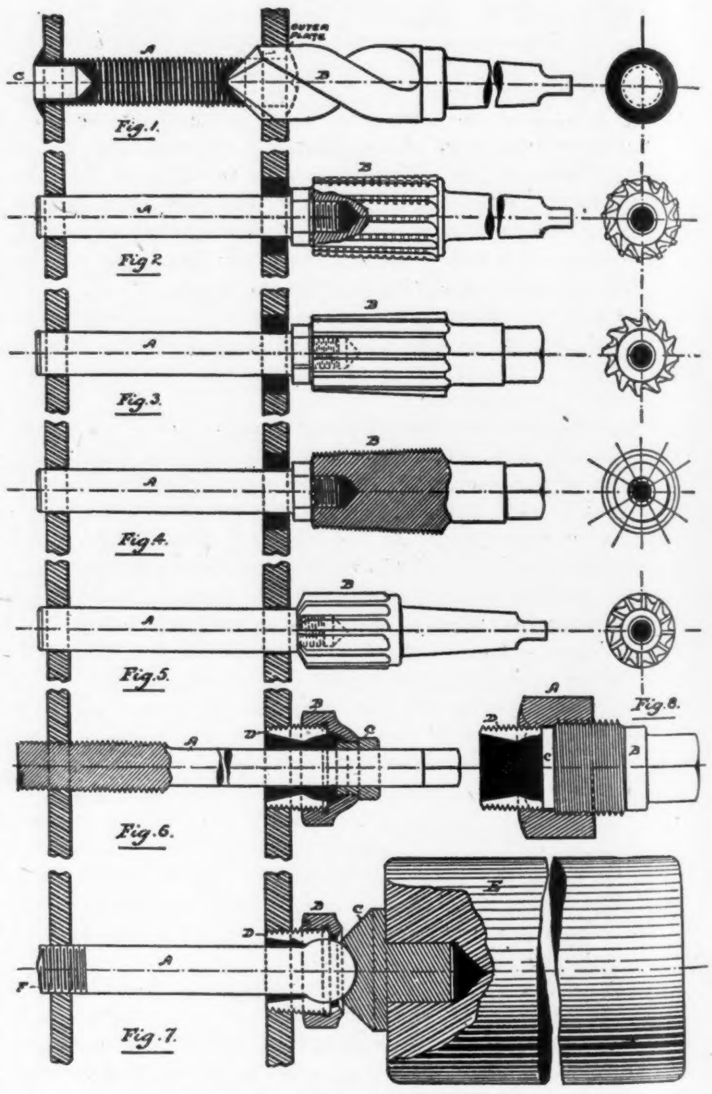
The style of bolt here shown can be put in place with an alligator wrench on the firebox end or by means of a slot in the head. Flexible staybolts should not be installed alternately, which has been done in some cases, for it is but a short time before the rigid water space stay has to be taken out and the flexible stay incorporated to effect a sensible installation. There is no rule to apply regarding the selection of the installation for flexible water space stays other than to cover completely the natural breaking zone of each style firebox.

The cost of flexible stays range from 40 cents to 70 cents apiece, complete, with bolt. The cost of installing the flexible water space stay with proper tool equipment and systematic methods should not exceed 25 cents per bolt, and when installed in large quantities the cost should be as low as 15 cents per bolt.

In comparing the relative cost of maintaining a firebox for four years having rigid staybolts in which the breakage amounted to 40 per cent. with a similar box in which 40 per cent. of the bolts were flexible, the author showed that the outlay for staybolts in the former would be $600 as against $328 for the latter.

The stresses which tend to rupture a staybolt are: That which operates to tear the bolt apart, the tensile stress; that tendency to break it, transversely or crosswise, due to expansion of fire sheet, the transverse stress; and that due to shear which tends to strip the threads from the bolt and hole in the sheet.

The fact that staybolt breakages have in no sense diminished, regardless of the quality of iron used and the many modifications of the forms devised in the rigid stay in the



INSTALLING FLEXIBLE STAYBOLTS.

effort to provide flexibility, notwithstanding that water spaces have been widened, leads us to conclude that the firebox as now constructed is too rigidly stayed to allow of economic and safe working where cost of maintenance of the complete machine is more or less affected in consequence of the expense accruing from the firebox and staybolt charges of repairs incident to the constant disintegration and destruction of material, the result of shock, strain, vibration, corrosion and heat.

The force which works on the fire sheet in its course of expansion, due to high temperatures of furnace heat, throws a stress on the outermost fibres of the rigid staybolt far in excess of the tensile stress, and as it is a reversal or vibratory stress the effect on the structure of the staybolt iron is too severe to warrant safe conclusions as regards maintaining a reasonable factor of safety.

The transverse stress breaks the rigid staybolt, not the tensile stress, and to enable the expansive forces to take their natural course with least resistance the flexible staybolt has been designed as a water space stay, as the most perfect means of affording and maintaining flexibility under all conditions of firebox service, adding to the life of both sheet and staybolt.

These comments and observations were presented in a paper before the Railway Club of Pittsburgh.

LIFTING MAGNETS.

A new application of electricity suitable for railroad shops, and one that promises to very greatly increase the efficiency of the electric crane in handling metallic material, is the lifting magnet, a few applications of which are shown in the accompanying illustration. While at the Wellman-Seaver-Morgan Company works, at Cleveland, the writer had an opportunity of seeing one of these magnets at work in the stock yard of the steel foundry. One of the most interesting operations was that of handling steel borings and turnings. It is practically impossible to shovel these, and it is very slow and laborious to handle them with a fork. With the magnet it was possible to take up about 700 lbs. of this material at one time, and this was hoisted about 15 ft. high, and the crane then carried it to the stock pile, 70 ft. away. Only 55 seconds elapsed from the time the magnet started to pick up the load until it had returned for another one. A short time ago five carloads of pig iron, averaging 30 tons to the car, were lifted out of the car to a height of about 15 ft. and transferred to the stock pile, 75 ft. away, in four hours.

To use the magnet, it is only necessary for the crane man to lower it over the object to be lifted and throw the switch which controls the electric current. Opening the circuit releases the load. No time is lost in adjusting chains, and the magnet never drops its load unless the operator cuts the current off. No ground helper is required except where it is necessary to adjust the load when small pieces, such as billets, are handled. Less room is required than where the ordinary forms of tackle are used, and the available storage room in stock or scrap yards is thereby considerably increased. The magnet is made from such a grade of steel that it drops its load instantly when the circuit of the energizing coil is opened. This coil is heavily insulated and treated by a vacuum impregnating process, which insures it against grounding or short circuiting. It is completely inclosed and protected by the heavy casting, which is ribbed to provide for the rapid radiation of the heat from the coil. The current is led to the coil through a plug connection, and when it is desired to detach the magnet from the crane hook this plug is simply pulled out. The controller switch for operating the magnet is placed in the crane cab.

The amount of current required to operate the magnet, of course, depends upon the amount and kind of material to be handled, but the comparatively small amount which is required under ordinary conditions is surprising. The illustrations show only a few of the many applications of this device. A special form of magnet is made for handling long iron or steel sheets. The magnet illustrated can easily handle six 100-lb. kegs of nails at one time. The writer saw it lift a 11,000-lb. skull cracker, used for breaking up very heavy defective castings. The entire operation was conducted from a safe distance by the crane man. The skull cracker was instantly detached, and the aim was very accurate, as there was no jerk of a latch hook rope tending to destroy it. A number of these magnets, which are made by the Electric Controller & Supply Company, Cleveland, Ohio, are now in successful operation. The device is not experimental, but is the result of years of experience.

HANDLING STEEL TURNINGS AND BORINGS.

LIFTING COILS OF WIRE.

UNLOADING CAR OF BUTTS OR CROP ENDS.

A FEW EXAMPLES OF WORK DONE WITH THE LIFTING MAGNET.

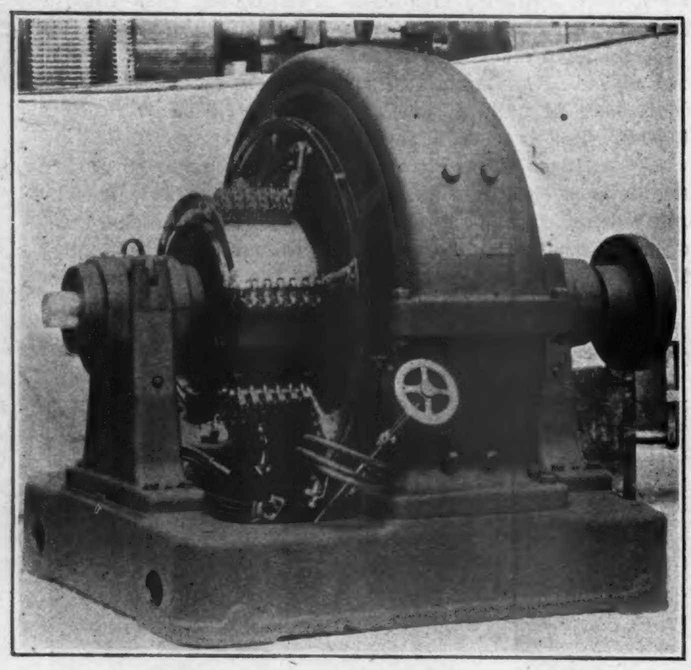
WESTINGHOUSE DIRECT CURRENT GENERATORS.

A new line of Westinghouse direct current self-contained generators, designed for railway, lighting and industrial service at 125, 250 and 550 volts, is shown in the accompanying illustrations. These generators are adapted for belt driving or for direct connection to water wheels, steam engines or other prime movers where frames with bearings are desired. While their general appearance differs from earlier forms, the essential features characteristic of Westinghouse apparatus have been retained, and the changes consist chiefly in the more efficient use of the materials employed in their construction and of mechanical modifications which make possible a more effective adaptation of the generators to modern methods of driving.

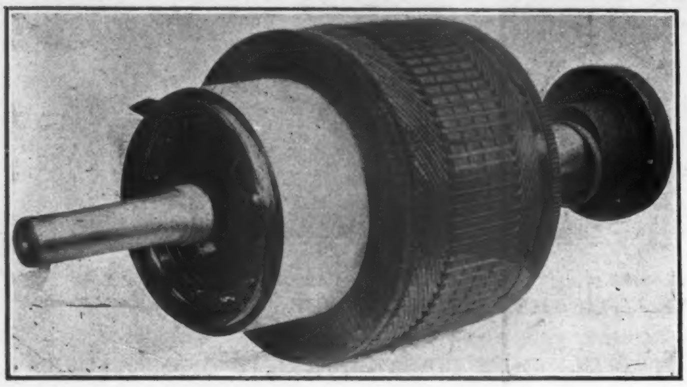
The frame consists of a circular yoke of cast iron divided horizontally into two parts and mounted upon a bed plate of cast iron, to which are bolted the pedestals which carry the armature bearings. Laminated poles with spreading tips are bolted to the frame, and any pole and its coils may be removed without disturbing either the armature or frame. The shunt and series field coils are separately wound and are held in place by the spreading pole tips. Ventilating spaces are provided between the coils and between coils and poles in such a way that thorough ventilation is secured. The coils are taped and impregnated by processes which make them entirely moisture proof. The field windings are regularly proportioned, so as to provide an increase of potential of about 10

per cent. at the terminals from no load to full load, though other compounding may be obtained if desired.

The armature core of the slotted drum type is formed of carefully annealed punchings built up on a cast iron spider, on an extension of which the commutator is mounted. Liberal ventilating ducts make possible a thorough circulation



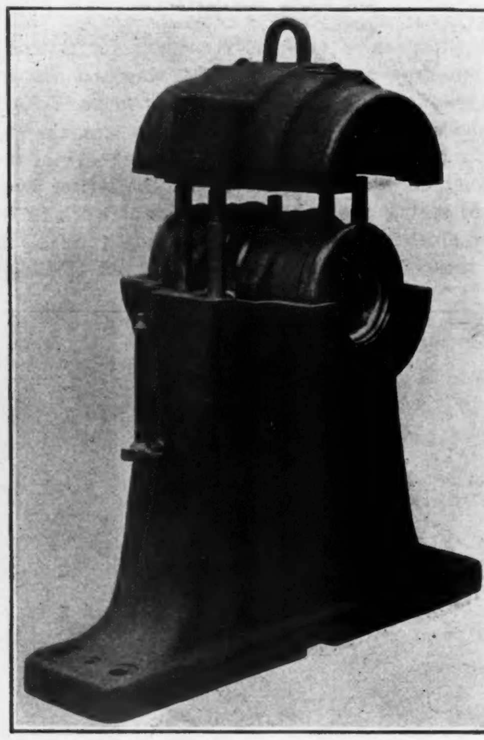
WESTINGHOUSE DIRECT CURRENT GENERATOR.



GENERATOR ARMATURE.

of air while the machine is in operation. Coils formed of copper strap are used, and are held in their slots by fiber wedges. The generous proportions of the commutator insure the best commutation and low temperature under all normal conditions of operation. No part of the rocker ring supporting the brush holder arms projects over the commutator, and the carbon holders and commutator are thus readily accessible at any point. The carbon holders are of the sliding type with shunts, the tension on the brushes being obtained by long, flat, spiral springs which give a uniform pressure over a wide range of movement without change in adjustment. The brushes and moving elements are light, and follow the surface of the commutator without chattering. Separate pedestals bolted to the bed plate support bearings of the Westinghouse self-oiling type, which consist of cast iron shells lined with babbitt metal and lubricated by means of rings which ride upon the shaft and dip into large reservoirs filled with oil. The bearing housings and shells are divided horizontally into two parts to facilitate mounting and removal.

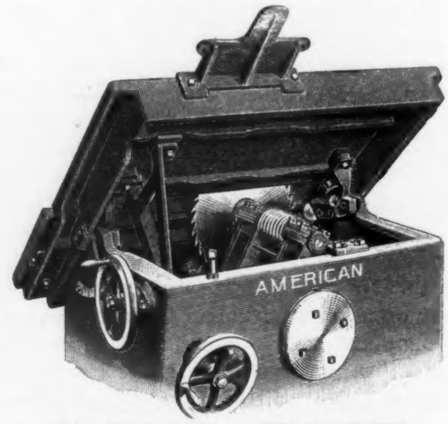
In the larger multipolar machines with parallel wound armatures, sparking at the brushes, wasteful heating in the armature winding and abnormal magnetic strain upon the armature—troubles occasioned by inequality in material or by displacement of the armature from the center of the field—are completely obviated by the following method of balancing the magnetic circuit. A number of points in the armature winding which are normally at equal potential are connected by leads through which balancing currents may pass from one section of the winding to others. These correcting currents are alternating in character, leading in some coils and lagging in others, and consequently magnetize or demagnetize the field poles in such a way as to produce the necessary magnetic balance.



PILLOW BLOCK, WITH CAP RAISED, SHOWING BEARINGS.

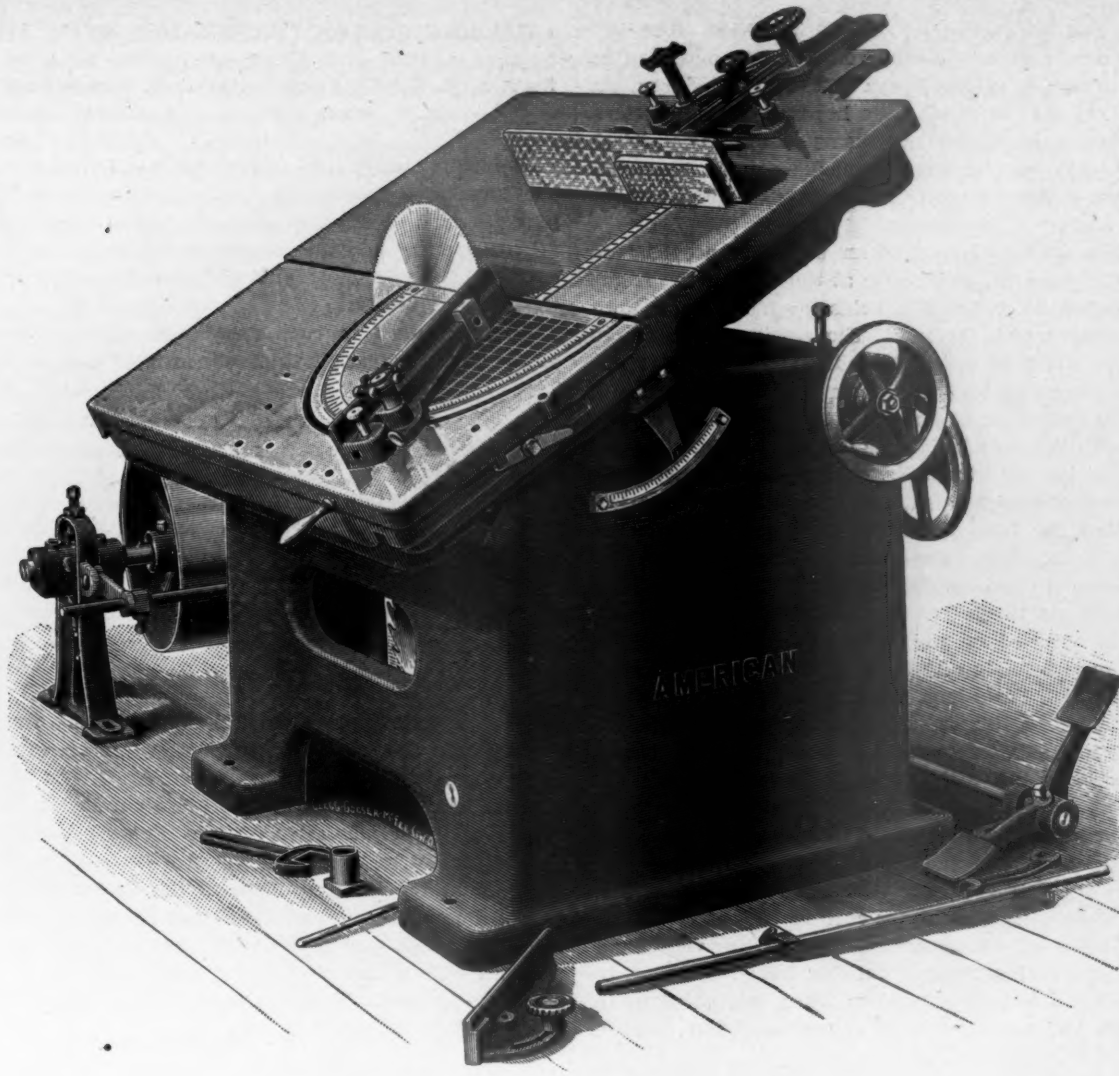
UNIVERSAL SAW BENCH.

The universal saw bench, illustrated herewith, is carefully designed for accurate cutting, and has a number of valuable improvements and attachments which enable it to turn out a great variety of work quickly and accurately. The box frame is cast in one piece, is massive and rigid, and has three points of support on the floor. The arbor yoke is extra long, and carries two cast steel arbors, 1¼ ins. diameter, with long self-oiling boxes and pulley between. The yoke swings on

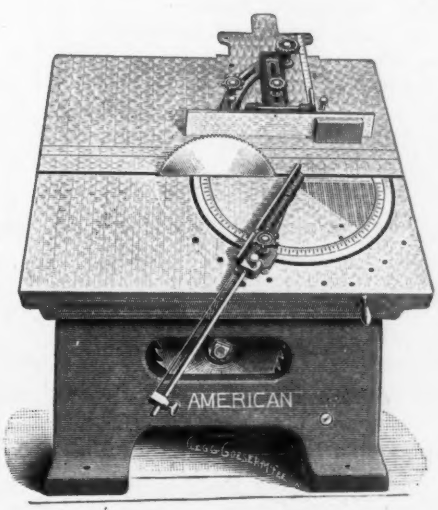


REAR VIEW WHEN TABLE IS TILTED.

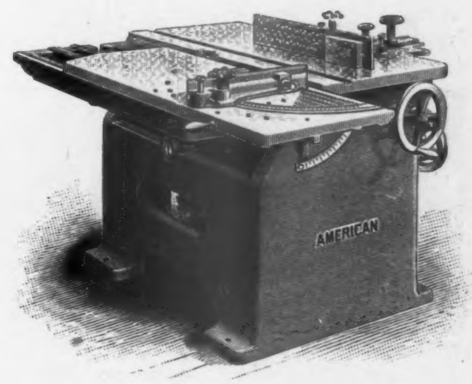
gudgeons on both sides of the saw line; the main one is 7 ins. in diameter, and has side-bearing shoulders 9½ ins. in diameter, with a suitable adjustment for wear; the circular adjustment is by means of a heavy worm wheel and a double pitch worm, with adjustments for wear both longitudinally and laterally; thus there need be no time wasted in changing saws, and no lost motion in the connections. The table is 45 ins. long, divided into two sections; the movable left-hand one is



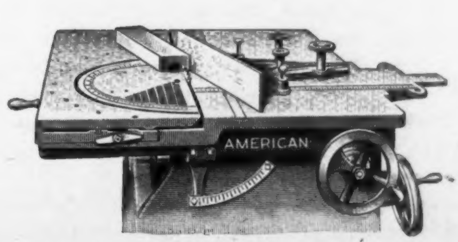
UNIVERSAL BENCH SAW.



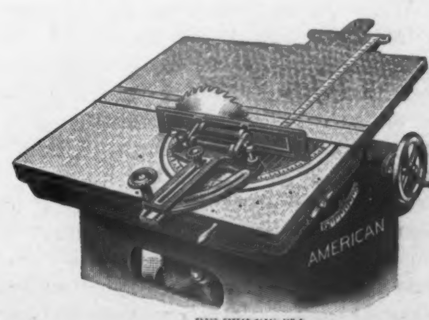
SHOWING ARRANGEMENT OF GAUGES.



FITTED WITH DADO HEAD AND SHOWING ROLLER TABLE.



SHOWING TABLE ARRANGEMENT FOR CUTTING CORE BOXES.



SHOWING RIPPING GAUGE ON THE ROLLER TABLE.

17 ins. wide and the right-hand one 22 ins. wide. The left-hand section moves on non-friction rolls, and by means of an intermediate frame or spider, it can be drawn away from the main section 2½ ins., to admit dado heads or special cutters. The entire table, which is unusually heavy and strongly ribbed, can be tilted to 45 deg., or any intermediate point, by means of a screw and radius arm, all the bearings of which can be adjusted for wear.

An accurately graduated arc and an index are provided on the front of the machine, and a stop at the rear of the frame directly in line of the radius arm holds the table, when down horizontally, square with the saw. The ripping gauge moves over the entire width of the main table, takes up to 24 ins. wide, and the fence tilts to 45 deg. from the vertical. The entire gauge also swings on one of the retaining pins to a horizontal angle with the saw, for cutting core boxes, etc. In addition to the position adjustment by means of the taper pins, there is a micrometer adjustment of 8 ins. by means of a steel rack and pinion cut from the solid, making the movement quick and accurate. The gauge may be transferred to the left-hand table when required, and there is on its face a detachable block which can be used as a cut-off stop. The cut-off or mitre gauge is swiveled on the rolling table section, and is accurately stopped by a taper pin at all the principal angles, in addition to which there is a complete half-circle protractor let into the table; to this is added a novel cross-graduated sector, by which angles corresponding to any required dimension of work can be cut without previously determining the angle, saving much time and calculation. For long work a steel rod is furnished with an adjustable end-stop, which recedes for cropping off ends, and can be used down to 2 ins. in length, and up to 5 ft. 3 ins. The right-hand table has a rule, graduated to inches and eighths for cutting off.

A supplementary cut-off gauge is fitted to the right-hand table, consisting of a long tongue, moving freely in a slot, to which is attached a swiveling head or fence, graduated to 45 deg. both ways, and arranged to be connected, when desired, with the main cut-off gauge by a yoke or arch which passes over the saw, and thus makes a long, well-supported gauge for large work. When the supplementary cut-off gauge is not in use, the fence may be detached from the tongue, and the latter turned over in its slot so as to make a flush surface on the table. A special sleeve is provided for the attachment of dado heads up to 2 ins. thick; this sleeve takes the place of the nut and loose collar on the saw arbor; heads thicker than 2 ins. at the eye will need to be recessed to receive the nut. This machine weighs complete about 2,250 lbs., and is made by the American Wood Working Machinery Company.

Largest Steel Casting.—The American Steel Foundries recently made a steel casting weighing 90,760 lbs. for the Blackwell's Island bridge at New York.

WELDING LOCOMOTIVE FRAMES WITH THERMIT.

By J. A. B. Gibson, Chief Draftsman, Richmond, Fredericksburg & Potomac Railroad.

In looking backwards within the last few years at the improvements in developing and maintaining our heavy and high-pressure locomotives, nothing has attracted the writer's attention more than the recent invention of the German scientist, Dr. Goldschmidt, and his process of welding known as the thermit process.

All mechanical railroad men know what a broken frame meant in times past, how it necessitated jacking the engine up, taking out the wheels and removing the frame to the smith shop; and even with our modern shops, equipped with electric cranes and similar conveniences, this is still an item of considerable expense, and the loss entailed in having the engine out of service often exceeds the actual cost of repairs.

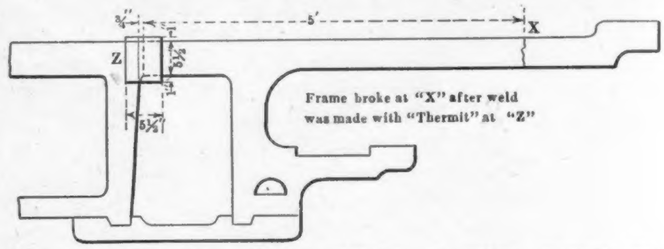


FIG. 1—LOCOMOTIVE FRAME SHOWING FRACTURE WHICH WAS WELDED BY THERMIT.

This process of welding locomotive frames was recently introduced at the Boulton shops of the Richmond, Fredericksburg & Potomac Railroad, and it has proved a perfect success in welding both cast steel and wrought frames. Our first experience with a cast steel frame was on one of our large Pacific type engines. This frame broke in the top rail between the pedestals, as shown by Fig. 1.

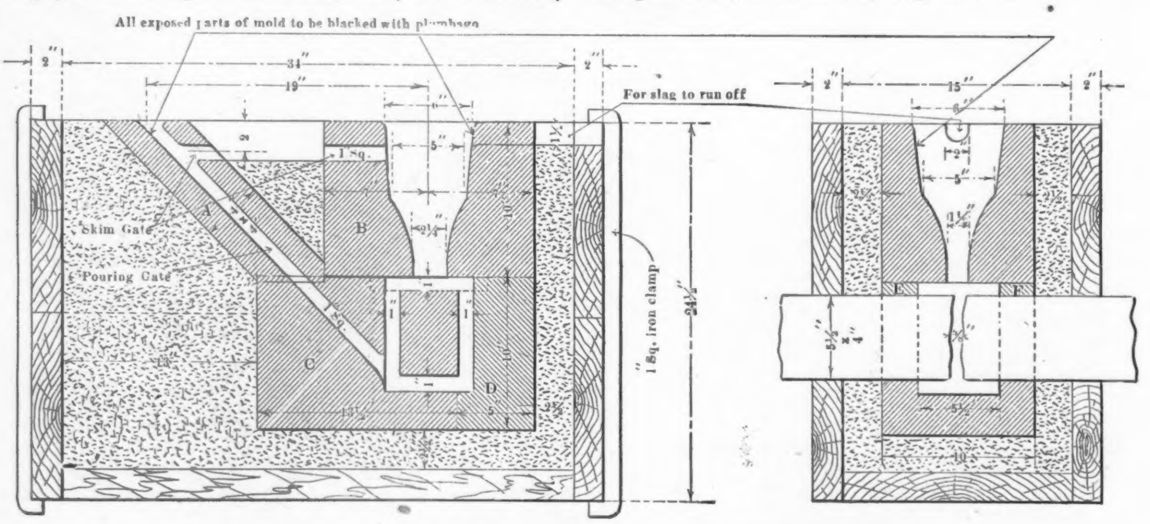


FIG. 2—MOLD USED FOR WELDING LOCOMOTIVE FRAMES WITH THERMIT.

The frame at the point of fracture was 5½ ins. deep and 4 ins. wide. After dropping the front pair of drivers and removing only that part of the spring rigging which would facilitate the work on the broken parts, the fractured ends were drawn together and the frame carefully measured, after which a number of ⅝-in. holes were drilled through the fracture and then chipped out, making a slot ⅝ ins. wide through the frame. To allow for the contraction caused by the cooling of the weld, the frame was sprung open ⅛ in. wider, making the total width of the slot ¾ in. The broken ends were then heated with a gas burner to remove all grease and dirt, and the frame was then ready to be welded.

Fig. 2 shows the mold used for welding the frame on this engine, which consisted of three parts of sharp core sand, three parts of river sand and one part of ordinary red clay. It

will be noted that the mold is in six sections; the advantages of this is that they are more easily made and placed in position. These sections are denoted on Fig. 2 by the large capital letters. The mold and also the sand surrounding the mold was thoroughly vented, to allow for the escape of gases. The mold was made to allow for a band around the frame 1 in. thick and 5½ ins. wide. To secure mold in position we used a wooden box, leaving a 3-in. space around the mold. This space being filled and rammed tightly with sharp sand. The advantages of using a wooden box are its cheapness and the rapidity with which it can be constructed and placed in position. The band was left on the frame except where it was necessary to remove it for the sake of clearance. In the case shown in Fig. 1 it was not necessary to remove any part of the band. All sections of the mold were covered with plumbago and thoroughly dried over a slow fire.

Care was taken to see that the crucible was large enough to allow for the reaction which takes place, and it was held securely in position by brackets attached to the running boards; as the vibrations caused by the reaction are liable to cause the metal to run outside the pouring gate opening and be wasted. This is of special importance when frames of high wheel engines are to be welded, as it is necessary to raise the crucible to a considerable height. The thermit was ignited with a red-hot rod, and a successful weld was made in less than one minute. After the metal had cooled sufficiently the mold was removed and the frame measured, which was found to be the original length. This frame had been in service for a number of months when it broke again 5 ft. from the thermit weld. This is shown on Fig. 1. It was necessary to remove the frame when the engine passed through the shops for repairs, but the thermit weld was not disturbed.

In making these thermit welds of both cast steel and wrought iron frames we obtained the same good results, and in no case was it necessary to hold the engines out of service more than two days. The importance of getting these engines in service so quickly was clearly demonstrated during our last busy season.

The proper amount of thermit necessary, with other information, is given in a circular published by the Goldschmidt Thermit Company. However, our experience has been that the best results are obtained by using a liberal amount of the composition mixed with 10 per cent. of small steel punchings.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION.—This association will hold its thirty-sixth annual convention at the Hollenden Hotel, Cleveland, September 12th to 15th inclusive. The program includes nine committee reports and topical questions. Detailed information may be secured from the secretary, Mr. Robert McKeon, Kent, Ohio.

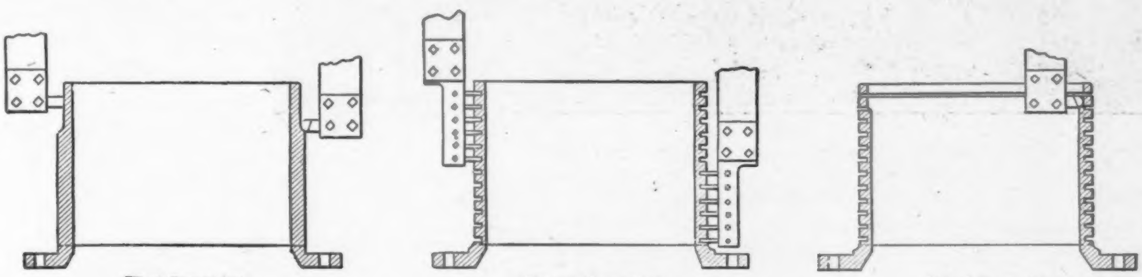
MORSE CHAIN COMPANY.—Recently an erroneous statement was printed in various journals to the effect that suit had been commenced by the "Westinghouse Interests" against the Link Belt Machinery Company. The suit in question was not brought by the Westinghouse Interests, but by the Morse Chain Company of Trumansburg, N. Y., who, on July 27th, filed bill in equity in the United States Circuit Court, Northern District of Illinois, Eastern Division, against the Link Belt Machinery Company for infringing on certain patent rights.

PRODUCTION IMPROVEMENTS.

PACKING RINGS FOR PISTONS.

Forty-eight packing rings in three hours and thirty-seven minutes, which is equivalent to 132 in ten hours, is a record made on a King 42-in. boring mill at the Washington, Ind., shops of the Baltimore & Ohio Railroad. These rings are of cast iron, ¾ x ¾ x 20½ ins. in diameter, and three operations as shown on the accompanying sketches, are required to finish them. About 3-16 ins. of material is roughed off on the inside and outside and the cutting speed for all the operations is about 52 ft. per minute.

The cylindrical casting is roughed off and finished on the outside at the same time. The next operation is to cut in the rings, and this is done with a special tool holder which is 1½ x 1¾ ins. in section and 8 ins. long, and carries 6 high speed steel cutting off tools. These tools slip into slots on the holders and are held in place by set screws. Using one of these holders in each head 12 rings may be cut in at the same time. The third and last operation is to finish the inside of the rings, at the same time cutting them off. We are indebted for this information to Mr. F. J. Smith, division master mechanic at Washington, Ind. The machine upon which this work was done was made by the King Machine Tool Company, and was described on page 60 of our February journal.



METHOD OF TURNING PACKING RINGS FOR PISTONS.

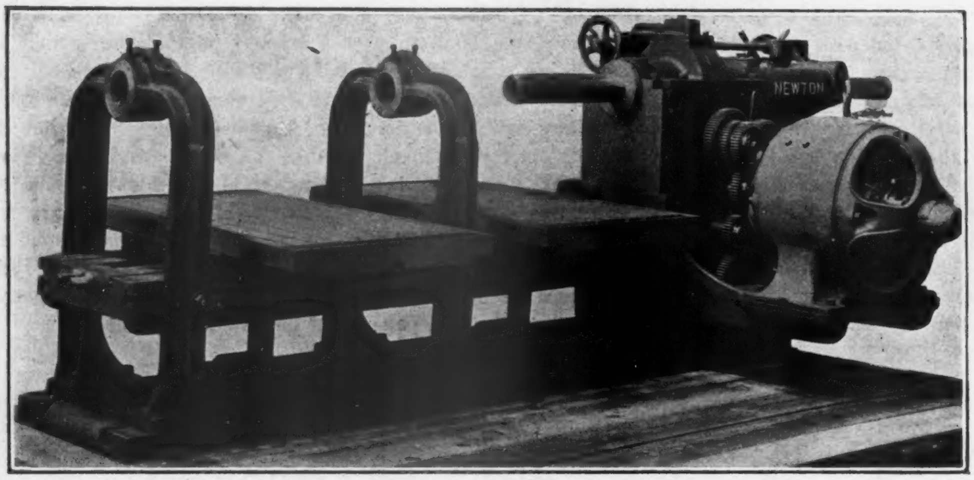
INCREASING THE MACHINE SHOP OUTPUT.—With the introduction of high-speed steel it was found on the road with which I am connected that it was possible to get an increased output if closer supervision was introduced; so in our machine shop an expert machinist was placed, whose duty it was to introduce improved methods, increasing the speed of the machinery and getting the maximum output. Each principal machine shop has an expert, and these experts visit the different shops, making reports, criticisms, recommendations and suggestions, which are taken up and discussed by the master mechanics, and the experts also meet and agree as to the methods, and universal practice which is applicable to the different shops. By the introduction of this system we have been able to increase our output very materially. We have been able to speed up our machines and increase our output to such an extent that formerly where on five pits we turned out one new engine per week we are now able to turn out two on the same pits, but, of course, we require more men to put them together.—*Mr. W. D. Robb, Canadian Railway Club.*

MASTER, THEN SHED DETAIL.—Master every detail of the work you are responsible for until you understand how it should be done and why. Then shed that detail as fast as you can on your subordinates. Aim always that you shall know at least as much, if not more, about the work than any subordinate; that no one under you shall long or permanently know more that is important about it than you. Get as big men under you as you can, but try always to be bigger yourself, and if that implies fresh study and fresh work, do it. Through all your work, and especially if you are called to executive positions, stand squarely for what is right; for integrity, straightforwardness, and honest dealing.—*Henry R. Towne, before Purdue students.*

HORIZONTAL BORING AND DRILLING MACHINE.

The Pennsylvania Railroad has recently installed in the Juniata shops a Newton horizontal boring and drilling machine for driving box work. Twelve boxes have been bored in one day on this machine, which is shown in the accompanying illustration, and it is expected that this will be increased to sixteen. Two boxes are set up on one end of each table and the four boxes are bored at the same time. While these are being bored four more boxes are set up ready for boring on the other end of the tables.

The spindle is 5 ins. in diameter and has a continuous positive automatic feed of 60 ins. with six changes in geometrical progression, giving a movement of from .0072 to .2646 ins. for each revolution of the spindle. The spindle also has hand adjustment and quick motion operated by hand. The spindle sleeve is driven by a phosphor bronze worm wheel and hardened steel worm which runs in a bath of oil and has a ratio of 11 to 1; the back gears have a ratio of 3 to 1, thus giving a total gear ratio of 33 to 1, with the back gears in. This drive furnishes a very smooth, steady motion to the spindle and is particularly adapted to work in which the hole to be bored is an incomplete circle, such as in driving boxes.



HORIZONTAL BORING AND DRILLING MACHINE.

The elevating knee is 9 ft. long, is raised and lowered by power and has hand adjustment. The tables are 36 ins. wide and 60 ins. long and have a cross adjustment of 36 ins. The elevating knee is 26 ins. wide and the two screws supporting it are 4 ins. in diameter. The boring bar is rigidly supported by the two yokes which are securely clamped to the base. The maximum distance from the center of the spindle to the carriage is 26½ ins. The machine is driven by a Westinghouse 10-h.p. variable speed motor with a variation of 2 to 1, and this range of speed is doubled by the back gears. The machine is made by the Newton Machine Tool Works of Philadelphia.

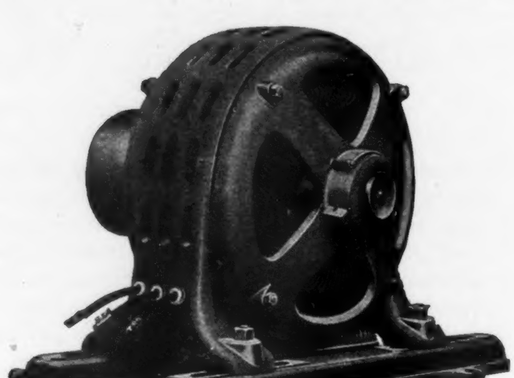
Limit of Speed of the Automobile.—A prominent French automobile engineer recently stated that it would not be possible for a modern racing automobile to exceed the speed of 130 m.p.h. while it is maintained at the present weight. M. Serpollet, the designer of the well-known steam car of that name, has therefore decided to approach this maximum as near as possible during this year. He is now constructing a steam car which he is confident will accomplish the kilometer in 18 seconds, or at an average speed of 125 m.p.h. The motor will develop over 200 h.p., and the weight of the engine without the steam generator or boiler will be only 330 lbs.—*Journal Franklin Institute.*

Travelling Engineers' Association.—This association will hold its thirteenth annual convention at the Cadillac Hotel, Detroit, Mich., commencing September 12th. The committee of arrangements has provided an exceedingly interesting program, and has made arrangements promising a most successful convention.

NEW LINE OF INDUCTION MOTORS.

A new line of constant speed induction motors has just been placed on the market by the Commercial Electric Company, of Indianapolis, Ind., for which the following claims are made: High power factor, large nominal breakdown factor, high efficiency at both heavy and light loads, low working temperatures, small idle currents and high starting torques. Although this company has heretofore confined its efforts to the manufacture of direct current machinery, the induction motors should not be regarded as experimental, as they have been carefully designed by engineers who for years past have been engaged in designing alternating current machinery for European manufacturers.

To produce a high power factor in these machines it is necessary to have a limited clearance between the external diameter of the rotor and the internal diameter of the stator. The design of the stator frame and head is such that an equal division of this clearance is always secured and maintained. A very large bearing is provided for the rotor shaft in order to reduce the wear to a minimum. The bearings are self-oiling and self-aligning, and are arranged so that the machines may be inverted if desirable. The linings of the bearings are interchangeable, so that the replacement of the bearings is simple and inexpensive. The shafts are of large diameter, and the distance between the bearings is reduced to a minimum in order to make them as rigid as possible. The rotors are forced on the shaft by hydraulic pressure. To insure cool operation ventilating apertures are provided across the faces of the stator and rotor cores. The starting device used with these machines is such that the starting current is practically reduced to that used with direct current motors of corresponding capacity. These motors are made in all standard sizes, voltages and frequencies and in both two and three phases, in 25 and 60 cycles.

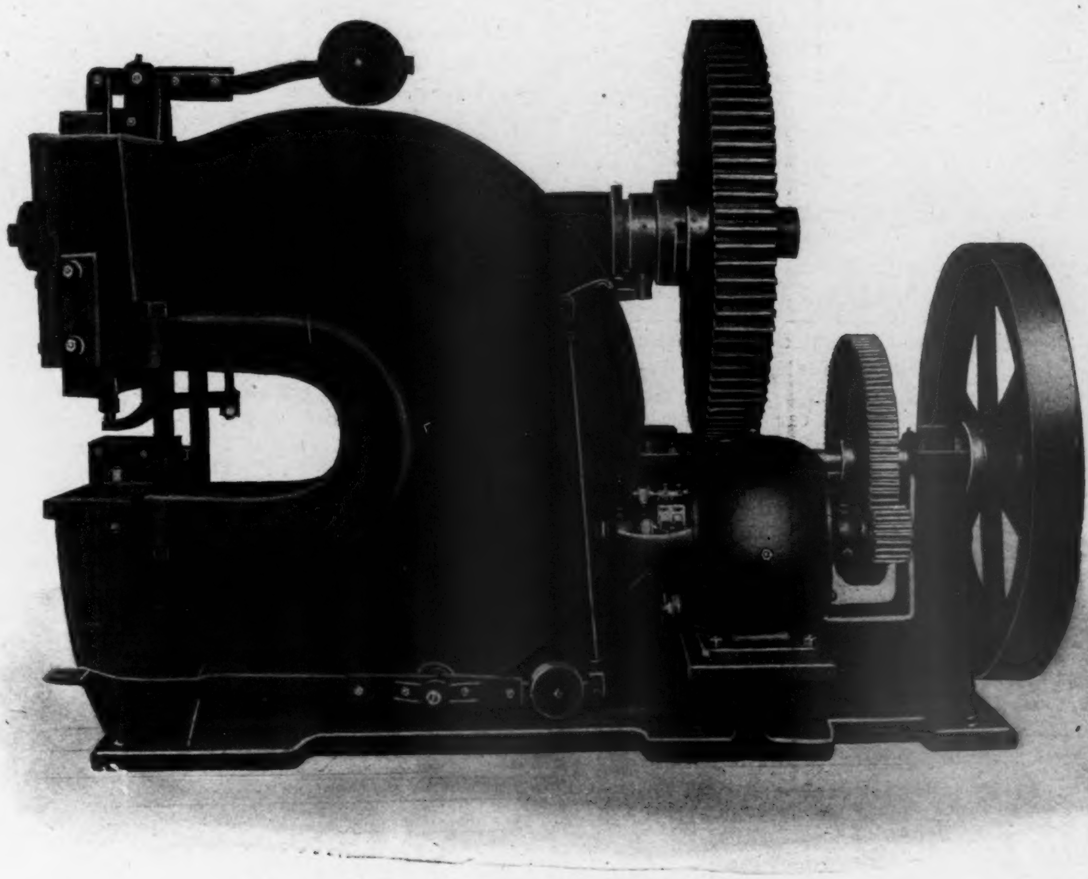


NEW INDUCTION MOTOR.

Electric Motors and Wood Working Machinery.—So far, I feel very much in favor of the D. C. transmission for machine shops. I am not talking from the point of view of the car department, although it does seem a pity that we cannot get a firm of car machinery making people to bring along motors that we can put on wood machines, instead of having the mass of belts as at present. I do not think there should be much trouble in getting an A. C. motor running 3,600 r.p.m. which would give us a motor on our wood machines. The belting is a large item in a wood mill.—*Mr. H. H. Vaughan, Canadian Railway Club.*

IMPROVED MOTOR DRIVEN PUNCH.

The illustration shows an improved Cincinnati punch equipped with the positive automatic stop and new sliding clutch which were illustrated and described in detail in our February journal, page 65. The adjustable stop allows the machine to be automatically stopped at any desired part of the stroke, and is especially valuable for exact center punching where it is desirable to have the tool stop close to the work. The section of the driving shaft upon which the clutch slides is square, thus doing away with the use of feathers or keys, and as the distance across flats is the same as the diameter of the round portion of the shaft the strength is considerably increased at what is ordinarily its weakest point.



IMPROVED CINCINNATI PUNCH.

The frame is of a heavy box section, with the walls extending considerably above the center of the driving shaft, thus making it very rigid. The sliding head is made extra long, with large bearing surfaces. The machine illustrated has a depth of throat of 24 ins., and will punch a 1-in. hole through 1 in. The lower jaw, which is used for standard punching, and also affords ample seat for the shear blocks, may be removed, and flange work may be done with a combination block. The motor is mounted upon a substantial cast iron bracket, and drives the machine through cut gears. These punches are made by the Cincinnati Punch & Shear Company, Cincinnati, Ohio, with depth of throat from 12 to 36 ins., single or double, and adapted for either belt or motor drive.

THE GOVERNMENT WANTS A DRAFTSMAN.—Civil Service examinations will be held September 13th and 14th for a vacancy in the position of architectural and structural draftsman, at $1,500 per year, in the Quartermaster's Department at Large, Washington, D. C. At the same time examinations will be held for constructing engineer for sewer and water works at Manila, Philippine Islands. Several men are wanted. Salaries ranging from $1,400 to $2,000 per year. Information concerning these examinations may be had from the United States Civil Service Commission, Washington, D. C.

ROUNDHOUSE HEATING AND VENTILATION.

In discussing locomotive terminal facilities before the Master Mechanics' Association Mr. H. H. Vaughan said, in part:

As far as heating and ventilating is concerned, I have had considerable experience both on the Lake Shore and the Canadian Pacific, and with the type of heating arrangement put in at Elkhart, the direct steam heating system (see AMERICAN ENGINEER, February, 1905, page 42, and March, page 80). A few years ago on the Lake Shore we equipped a total of 16 roundhouses with that arrangement, and for six years on the Canadian Pacific road we have heated eight roundhouses by this system, and in all cases the results have been most satisfactory. We have not only been able to warm the houses, but we have done it at a saving in the coal consumed for heating over that which was used in previous years, the saving in coal alone being sufficient to justify the cost of putting in the heating plant, which I consider a very satisfactory result. The Elkhart roundhouse was constructed with a definite end in view. That was that the cold air, entering under the doors, would be warmed by the pipes in the pit, and as the air ascended to the roof of the house it would carry with it the steam and smoke so common in roundhouses. That idea, I think, has been amply carried out in practice, and I feel very strongly that that form of house is the best cross-section of house that has so far been devised if we want to keep the house clear of smoke and steam. At the last convention, when we had a topical discussion on this subject, I mentioned that we were going to inclose the turn-table in the house. While that plan has been moderately successful, it has not been entirely so. The house we inclosed was heated with hot air in place of direct radiation, and the troubles that are so frequently met with in hot air heating were very much accentuated in the closed house—that is, the drawing back of the smoke through the heat fan and being thoroughly mixed with the air and driven out again, so that the whole house is filled, not with smoke that is opaque, but with smoke which affects the eyes and lungs of the men. I feel that if the house had

been heated with direct radiation, so that in place of having a horizontal circulation of air we should have obtained a vertical circulation of air, that we should have had a successful house. The horizontal circulation of air which you get in a house heated with hot air is extremely troublesome unless the ventilation is first-class. There is a tendency to draw the smoke into the fan. The hot air people tell us we can correct that by taking in more outside air, which is perfectly correct; but if we take in more outside air we run up the expense of heating the air very rapidly. All the cold air coming in has to be warmed up to the temperature of the house, in place of having to be kept warm, and in a cold climate that is impracticable on account of the expense. After an experience which we have had in the last two years I agree that the system of heating and ventilation of roundhouses suggested in the report is probably the best, and I believe that system will avoid nearly all of the smoke and steam troubles provided one thing is attended to, and that is the proper height of jack and ventilator. We found that a short jack and short ventilator did not relieve the smoke trouble. We are now putting in ventilators 20 or 25 feet high, in order to get a good vertical draft through them.

PERSONALS.

Mr. Edgar Shellabarger has been appointed master mechanic of the East Broad Top Railroad at Orbisonia, Pa.

Mr. H. F. Smith has been appointed car foreman of the Lake Shore & Michigan Southern Railway at Collinwood, Ohio.

Mr. F. W. Williams, master mechanic of the Delaware, Lackawanna & Western at Buffalo, N. Y., has resigned.

Mr. E. G. Bryant has been appointed master mechanic of the International & Great Northern at Mart, Texas.

Mr. C. M. McLain has been appointed master mechanic of the International & Great Northern at Taylor, Texas.

Mr. A. P. Prendergast has been appointed assistant master mechanic of the Mt. Clare shops of the Baltimore & Ohio.

Mr. G. O. Hammond has been appointed mechanical engineer of the Erie Railroad at Meadville, Pa., succeeding Mr. A. G. Trumbull, promoted.

Mr. J. Kirkpatrick has been appointed master mechanic of the Baltimore & Ohio at Cumberland to succeed Mr. T. R. Stewart, promoted.

Mr. J. B. Elliott has been appointed master mechanic of the Baltimore & Ohio Railroad at Newcastle Junction, Pa., to succeed Mr. J. Kirkpatrick, transferred.

Mr. H. P. Hunt, assistant mechanical superintendent of the Erie Railroad at Meadville, Pa., has resigned, to enter the service of the American Locomotive Company.

Mr. E. E. Crysler has been appointed master mechanic of the Cincinnati, Hamilton & Dayton Railroad at Indianapolis, Ind., to succeed Mr. J. W. Connaty, resigned.

Mr. T. R. Stewart, master mechanic of the Baltimore & Ohio at Cumberland, Md., has been appointed master mechanic of the Philadelphia, Baltimore & Shenandoah divisions of the Baltimore & Ohio.

Mr. A. G. Trumbull has been promoted from the position of mechanical engineer of the Erie Railroad at Meadville, Pa., to that of assistant mechanical superintendent, succeeding Mr. H. B. Hunt, resigned.

Mr. G. Willius, Jr., has been promoted from the position of assistant mechanical engineer to that of mechanical engineer of the Great Northern Railway to succeed Mr. R. D. Hawkins, promoted.

Mr. H. A. Child, formerly master mechanic of the Erie Railroad at Jersey City, has been appointed superintendent of motive power of the Guayaquil & Quito Railway in Ecuador.

Mr. H. P. Meredith has been appointed engineer of motive power of the Pennsylvania Railroad at Jersey City, succeeding Mr. Elliott Sumner. He was formerly assistant master mechanic at Altoona.

Mr. Elliott Sumner has been appointed engineer of motive power of the United Railroads of New Jersey division of the Pennsylvania Railroad, being promoted from the position of assistant engineer of motive power.

Mr. Thomas J. Tonge has been appointed master mechanic of the Zuni Mountain Railway at Thoreau, Mexico. He has heretofore been roundhouse foreman of the Atchison, Topeka & Santa Fe Coast Line at Winslow, Ariz.

Mr. T. E. Adams has been appointed superintendent of motive power in charge of all rolling stock, locomotives and machinery of the St. Louis, Southwestern, with headquarters at Pine Bluff, Ark. Heretofore his title has been general master mechanic.

Mr. Charles J. Donohue, chief clerk of the motive power department of the Lake Shore & Michigan Southern, has been made secretary to the general manager at Cleveland, to succeed Mr. F. E. Woodruff, assigned to other duties. Mr. Donohue has been chief clerk of the motive power department for a number of years.

Mr. G. M. Dow has been appointed general mechanical inspector of the Lake Shore & Michigan Southern Railway, with headquarters at Cleveland, Ohio. Mr. Dow has been master car builder for a number of years. The duties of the master car builder at Collinwood have been assumed by Mr. S. K. Dickerson, master mechanic, and Mr. M. D. Franey, superintendent of shops at that point.

BOOKS.

Steam Engineering. A Treatise on Boilers, Steam, Gas, and Oil Engines and Supplementary Machinery. By W. W. F. Pullen. Published by the Scientific Publishing Co., Manchester, England. Price, 4s.

This work opens with a synopsis of mechanical laws and definitions, followed by descriptions of the construction of steam turbines, steam engines and boilers. It includes chapters on measuring pressure power and work, the measurement of heat, descriptions of auxiliary machinery, valves and internal combustion engines. The scope is large and in the hands of a class directed by a competent instructor a very general idea of the subject may be obtained. Twelve pages only are devoted to the locomotive.

Practical Perspective; by Richards-Colvin; published by the Derry-Collard Company, 256 Broadway, New York.—This pamphlet of 60 pages clearly presents the principles of isometric perspective, which the author considers the only practical perspective for mechanical work. The second part of the book presents a large number of illustrations for the use of perspective paper for making rapid sketches; this includes architectural details, lathe work, locomotive details and a number of convenient applications. The object of the book is to show the practical value of isometric perspective by removing the difficulties which have prevented its wider use. The Derry-Collard Company sends a copy of the book and two pads of the isometric sketching paper for $1.

Basis of Railway Rates and Private vs. Governmental Management of Railroads. By Marshall M. Kirkman. Published by the World Railway Publishing Co., 79 Dearborn Street, Chicago, 1905. Price, $2.50.

This book is a reprint in part, of a work by the same author which appeared several years ago. It is specially opportune just now, because of the general interest in rate making and the popular demand for governmental control of rates. The author shows that since 1863 rates per ton mile have dropped from 3.642 to 0.763 cents. From this the public received a dividend of 42.9 per cent. on the total cost of the railways of the country, whereas the bonds brought a return of only 3.74 per cent. He says, "The truth is that air and water do not adjust themselves more naturally than

the rates of railways adjust themselves to the vicissitudes of trade. If there are exceptions the evil contains its own cure, and so does not invite statutory enactments." The book elaborates the theory and practice of rates from the standpoint of a railway official of many years of experience.

Electrician's Handy Book. By T. O'Conor Sloane. A modern work of references, a compendium of useful data, covering the field of electrical engineering. 761 pages, 4½ by 6½ ins. in size, with 556 illustrations. Published by the Norman W. Henley Company, 132 Nassau street, New York. Price, $3.50.

This convenient book treats of the theory of the electric current, circuits; electro chemistry; primary batteries; storage batteries; generators and utilization of electric power; alternating current; armature winding; dynamos; motor generators; central station operation; switchboards; lighting; electric measurements; electric railways; telephony, and wireless telegraphy. The work gives in simple, compact, yet comprehensive form, a great deal of descriptive information concerning electrical machinery, its construction and its use. It is a very convenient handbook, and is evidently intended specially for those who do with the operation of power stations. Its field, however, is much larger than this, and many not having to do directly with electrical machinery will be very glad to have the book within reach for ready reference. The publishers are to be complimented upon the letter press, the index and specially clear engravings.

CATALOGS.

INDUCTION MOTORS.—Circular No. 200 from the Commercial Electric Company, Indianapolis, Ind., describes their new line of induction motors.

SHAPERS AND GRINDERS.—Catalog D from the Cincinnati Shaper Company, Cincinnati, Ohio, describes their shapers of pillar, column and traverse types and their new line of traverse grinders.

FROGS, SWITCHES AND CROSSINGS.—Catalog A from the Weir Frog Company, Cincinnati, Ohio, is devoted to light rail work for use in tracks of electric roads, coal mines, plantations and factories.

NORTHERN SPHERICAL MACHINES.—The new bulletin No. 50 of the Northern Electrical Manufacturing Company describes their spherical dynamos and motors. These are shown in a large variety of applications, including a number of machine tool drives.

THE JANITOR AND THE LIBRARIAN.—Another one of those characteristic little pamphlets from the Lucas Machine Tool Company, of Cleveland, O., concerning the advantages of the Precision boring, drilling and milling machine and their power forcing press.

ELECTRIC CONTROLLERS.—Circular No. 1108 from the Westinghouse Electric & Manufacturing Company, Pittsburg, Pa., is devoted to a description of the Westinghouse regulating and reversing controllers. Applications of these controllers to machine tools, cranes and elevators are shown.

FLANGED PIPE JOINTS.—The Crane Company, of Chicago, have issued a treatise concerning the merits of the various styles of joints used in attaching flanges of wrought pipe; these include screw joints, "Crane lap," "Crane weld," shrunk, riveted and rolled joints, with comments upon the merits of each.

ELECTRICAL APPARATUS.—Bulletin No. 60 from the Crocker-Wheeler Company, Ampere, N. J., contains a description of their small direct current motors, ¼ to 3 h.-p., and illustrates several interesting applications to machine tools. Bulletins Nos. 56 and 57 describe their generating sets with Case and Forbes engines.

ALTERNATING CURRENT THREE PHASE TRACTION.—An elaborate publication issued by the Railway Electric Power Company, New York, setting forth the characteristic features and advantages of the Ganz three phase alternating current traction system, with special reference to the results obtained from its three years' use abroad.

ELECTRIC MOTORS AND TRAILER TRUCKS.—The Baldwin Locomotive works in their Record Of Recent Construction No. 50, illustrate thirteen motor and trailer trucks for electric railway service, each page illustrating a truck being accompanied by a page containing descriptive information. The pamphlet is in the usual attractive form of the Baldwin publications.

STEAM TRAPS.—Catalog from the Youngstown Steam Trap Company, Keystone Bank building, Pittsburg, Pa., describing the Youngstown steam trap.

SOFT WATER.—The Kennicott Water Softener Company, Railway Exchange, Chicago, Ill., have issued a handsome pamphlet presenting a reprint of the articles on "Water Softening" on the Pittsburg & Lake Erie Railroad, which appeared in this journal in January, February, March and April of this year, by G. M. Campbell, electrical engineer of the road.

GAS PRODUCERS.—The Morgan Construction Company, Worcester, Mass., has issued a very complete and handsome catalog, describing the construction and considering at length the operation and advantages of the Morgan continuous gas producer. Details of a test made by Robt. W. Hunt & Company are given, showing an average efficiency of 92 per cent.

AIR BRAKE LUBRICATION.—The Joseph Dixon Crucible Company, of Jersey City has issued a little pamphlet devoted to the subject of air brake lubrication and the application of graphite in air brake practice. The opinion of Professor Goss as to the efficacy of graphite on air brake triple valves, as reported to the Master Car Builders' Association, is quoted, and the desirability of graphite for this purpose is fully shown. The pamphlet includes directions for the use of this lubricant for triple valves, brake valves, brake cylinders, pistons and air pumps. Abundant testimony is furnished by the records of discussions before the railroad associations and by articles in the railroad papers of the necessity for improving the lubrication of the moving parts of the air brake. This pamphlet should be brought to the attention of all who are responsible for the operation and maintenance of air brake practice on all railroads.

NOTES.

An announcement of the sudden death of Mr. Frederick Schurchman, vice-president and general manager of the Homestead Valve Manufacturing Company, has been received. His death occurred July 25th at Homestead, Pa.

INDEPENDENT PNEUMATIC TOOL COMPANY.—Mr. Charles Parsons, of Chicago, has become associated with this company. Mr. R. S. Cooper, formerly with the Rand Drill Company, has been appointed manager of the New York office at 170 Broadway.

PRATT & WHITNEY.—This company has made arrangements with the C. T. Patterson Co., Ltd., of New Orleans, La., to represent their small tool department in the Southwest territory. The Patterson Co. have a very complete line of small tools, and are in a position to fill orders from their New Orleans establishment.

S. F. BOWSER & COMPANY.—Mr. William T. Simpson, formerly with the Detroit Lubricating Company and more recently with the American Locomotive Equipment Company, has accepted a position with S. F. Bowser & Company, of Fort Wayne, Ind., manufacturers of the Bowser oil storage systems and oil house equipments.

A. C. STILES ANTI-FRICTION METAL COMPANY.—Mr. Henry W. Toothe has resigned his position as manager of the railway department of the Magnolia Metal Company, and has accepted a position as manager of the Babbitt Department of the A. C. Stiles Anti-Friction Metal Company, of New Haven, with headquarters in New York City.

CHICAGO PNEUMATIC TOOL COMPANY.—The semi-annual statement of the financial condition of this company shows total profits for the half year of $413,941.54. The amount available for dividends is $273,736.52, and the balance carried to surplus $151,460.86. The surplus carried forward is $376,898.17, showing a very successful half year.

THE STERLING EMERY WHEEL COMPANY.—This company has moved its store in Chicago, Ill., from 65 S. Canal street to 30 and 32 S. Canal street, the building at the former location having been badly damaged by fire in July, 1905. The managers of the Chicago store will be glad to receive trade papers and catalogues of all kinds of machinery pertaining to their line.

New Jersey Tube Company.—This company, of Newark, N. J., announces that the Maine Central has specified their spirally corrugated boiler tubes on all the new engines recently ordered.

Crocker-Wheeler Company.—The Proctor & Gamble Company have ordered a 200-k.w., three phase, 60 cycle engine type alternating current generator for their Ivorydale, Ohio, lighting and power plant. This is a duplicate of the first alternator ever built by the Crocker-Wheeler Company, which was installed at the Proctor & Gamble Company plant at Atlanta ten months ago.

Krips-Mason Machine Company.—This company of 1636 North Hutchinson street, Philadelphia, Pa., exhibits a cutting and punching machine at the Lewis and Clarke Centennial Exposition at Portland, Ore. These are the only Eastern manufacturers of punching and cutting machinery exhibiting. They also distributed samples of washers of metal and fibroid cut by their machines.

Wm. B. Scaife & Sons Company.—The Midland Steel Company, Pittsburg, Pa., who are to erect a large blast furnace plant at Midland, Pa., have placed contract with Wm. B. Scaife & Sons Company, Pittsburg, Pa., for six steel frame buildings; also crane-runways and other steel work. A very large tonnage of structural shapes and plates will be required in this connection.

The D. T. Williams Valve Company.—This company has just arranged for the exclusive manufacture and sale of the Cookson steam trap and separator, formerly manufactured by the Cookson Steam Specialty Company. This steam trap is very well known throughout the country. It is extremely simple and accessible. A twelve-page pamphlet will be sent upon request to the D. T. Williams Valve Company, 904 Broadway, Cincinnati, Ohio.

Locomotive Appliance Company.—At the annual meeting held in Chicago, August 10th, the following directors were elected for the ensuing year: Messrs. J. H. McConnell, Pittsburgh, Pa.; E. B. Lathrop, Frank W. Furry, Ira C. Hubbell, J. B. Allfree, Willis C. Squire, J. J. McCarthy, of Chicago; W. J. McBride, Clarence H. Howard, B. F. Hobart and C. A. Thompson, of St. Louis, Mo. Mr. McConnell was elected to take the place of Dr. G. W. Cale, Jr., resigned.

George H. Gibson & Company.—Mr. H. P. Gillette, formerly associate editor of *Engineering News*, and Mr. George H. Gibson, formerly manager of publicity for the International Steam Pump Company, have formed a partnership as "advertising engineers," under the name of George H. Gibson & Company, with offices in the Park Row building, New York. They are organized to undertake a firm's advertising in the same manner as would a department in the firm's own offices. Both of these gentlemen are prepared to render valuable service because of their training and experience.

The Morse Chain Company.—This company, located at Trumansburg, N. Y., are now building at Ithaca, N. Y., a plant of about five times the present capacity. The company was incorporated in 1898, no change having been made either in the name or personnel since starting, Mr. F. L. Morse being the treasurer and general manager. The plant was originally started for the manufacture of bicycle chains, but in 1901 they brought out the present high-speed, silent running chain, and since that time have had a rapidly growing business. In the line of power transmission the Morse Company have in service chains transmitting over 75,000 h.p., and are furnishing drives up to 500 h.p. for a single transmission.

Searchlight Publishing Company.—Mr. W. M. Probasco announces that he has become associated with Mr. E. G. Handy and Mr. W. G. Jordan in the publication of the "Searchlight." This company has four departments comprising one for the publishing and advertising interests of important mechanical manufacturers, engineering firms and railroads; one for the publication of the "Searchlight," keeping up-to-date the "Searchlight Information Library" and the publication of books. The "Searchlight" is a condensed, classified and up-to-date history of the 20th century, issued weekly, covering sixty separate departments. It is intended that nothing of real importance shall escape its editors. The four branches of the business of this company constitute a very large undertaking, with which the gentlemen concerned are fully capable of coping.

American Blower Company.—Mr. J. R. McColl, a man of high standing in his profession, who was until the close of the last college term associate professor of steam engineering at Purdue University, has decided to take up commercial lines and has accepted a responsible position in the engineering department of the American Blower Company at Detroit, Mich. The National Tube Company has placed a large and important order, for immediate execution, with the American Blower Company. The contract embraces complete heating equipment for their five new butt weld mills at Lorain, Ohio.

Melting Snow from Locomotives.—Not long since, ten existing stalls in the roundhouse of the N. Y., O. & W. R.R. Co., at Middletown, N. Y., were equipped by the B. F. Sturtevant Company, of Boston, Mass., with a system of heating and ventilation particularly designed to rapidly remove the snow and ice from the running gear of the locomotives during the winter season. This house has recently been doubled in size, making twenty stalls in all, with ¾ of a million cu. ft. of space. It is stated that during the past winter when the thermometer was from 5 to 20 deg. below zero, engines could be thawed out in from one to two hours, although completely covered with snow. In the old roundhouse which this superseded, and in which the pits were equipped with steam pipes, it required from five to six hours to accomplish the same result.

Vertical Variable Speed Motors.—These motors enable the machine designer to do away with the necessity of turned belt, beveled gears, etc. The equipment makes the driven machine far more compact in arrangement, and, of course, secures far greater economy of operation than is possible by ordinary means of power transmission. The Northern Electrical Manufacturing Company, Madison, Wis., has paid special attention to the development of vertical motors, and in the design eliminates all of the troubles due to lubrication of a vertical armature shaft. These motors are extensively employed in all fields of work. Where required the Northern single voltage system is applied to the vertical motors, thus making it possible to operate the driven machine at the speed best suited to the requirements of the work. Simple controlling devices are used with this system, and the motors operate from any ordinary two wire single voltage direct current circuit.

The Buffalo Forge Company.—The Erie Railroad has awarded to the Buffalo Forge Company the following contracts: Heating and ventilating outfit for the 42-stall roundhouse at Buffalo, requiring a 220-in. fan belted to a 75-h.p. motor, and a heater containing 15 four-row sections, each section being 6 ft. by 8 ft. 4 ins. A heating and ventilating outfit for the 43-stall roundhouse at Hornellsville, N. Y., requiring a 210-in. fan belted to a 60-h.p. motor, and a heater containing 20 two-row sections, each section being 7 ft. by 9 ft. 4 ins. Another outfit for the 21-stall roundhouse at Galion, Ohio, requiring a 150-in. fan driven by an 8 by 10-in. Buffalo engine, and a heater containing 10 four-row sections, each section being 5 ft. by 6 ft. 10 ins. And, fourth, a heating and ventilating outfit for the 21-stall roundhouse at Huntington, Ind., requiring a 150-in. fan driven by an 8 by 10-in. Buffalo engine, the heater containing 12 four-row sections, each section being 5 ft. by 6 ft. 10 ins. The pipe alone used in these heaters, if laid continuously, would cover a distance of almost 6½ miles.

Dependable Hydraulic Jacks.—Unless a hydraulic jack is absolutely reliable, the engineer, mechanic, railroad man or whoever is using it, is better without it. Just at the critical moment, when everything depends on a jack "standing up," a poorly made device is liable to give away. The consequences are best left to the imagination, they are not pleasant, even to imagine. In the Watson-Stillman hydraulic jacks, every such element of uncertainty is eliminated, hence the confidence reposed in them by those who have to trust life and limb to the dependability of a hydraulic jack. The cylinders and rams, for which, in some makes, so-called seamless tubing is thought good enough, are in the Watson-Stillman jacks forged from solid steel billets, forged and bored like the cylinder of a high-class steam engine. Valves, glands, pistons, etc., are made and finished with equal care, packings and other parts subject to wear are easily accessible and replaceable, the result being a hydraulic jack so thoroughly dependable and constantly ready for service, that it holds first place among this class of tools. The manufacturers, Watson-Stillman Company, 46 Dey street, New York, have a list of about 300 styles of hydraulic jacks, which they will send on request.